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†In marine separate.

CORRECTION

MONTHLY WEATHER REVIEW, May, 1918, page 241: In the table the crest stage at Knowlton, Wis., should be "15.7" on the 27th, instead of "13.4" on the 29th.

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FLUCTUATIONS IN THE VALUES OF THE SOLAR CONSTANT

By Dr. C. DORNO

[Davos, Switzerland]

In February, 1923, Dr. C. G. Abbot wrote (*1*) "Arrangements have been made to continue daily observations at both stations (Harqua Hala and Montezuma) until July, 1925, when it will be earnestly considered whether they should continue longer, and if so, under what auspices." This was understood here to mean that Doctor Abbot intended by the date mentioned to summarize and criticize his ingenious and almost superhuman undertaking for the continuous observation of the solar constant, and no attempt was therefore made to touch publicly upon a remarkable point in connection with Table 8, which was published at the same time by Abbot (loc. cit., pp. 78–81), and the relationship with a certain natural occurrence shortly to be mentioned. The report on the matter was merely passed on to the president of the International Radiation Commission, Professor Maurer, with a letter dated April 15, 1924, requesting him to retain it for the time being with the documents. Doctor Abbot has now published the criticism referred to (*2*), and it is most valuably supplemented by the detailed criticism, which accords with the importance of the subject, of Doctor Marvin, Doctor Kimball, and Mr. Clough. (*3*). In all these criticisms the important point, which to me appears a very striking one, was not referred to, and I take leave, therefore, in the present remarks to draw attention to it.

Reference has, indeed, been made here and there in the literature to a great volcanic eruption which took place in the middle of December, 1921, in the Chilean-Argentine Andes (in the Astronomische Nachrichten, No. 5279, the site of the volcano is given as λ 72°, ϕ 40°), but it would seem that the great importance of the occurrence has perhaps not been fully realized. In January, 1922, I happened to see a detailed description from the pen of a young Davoser engaged on a farm near Huapi on the Lago Nahuel (λ 71°, ϕ 41°). His report on the occurrences of December 15, 1921, was to the following effect:

> A terrific storm, with dreadful flashes of first yellow, then red, then green lightning, and a severe earthquake were followed at midday by a great darkness and a rain of snow-white ashes that began to fall on December 15 and was still falling on December 17—the date of writing the letter. Abundant quantities of pumice also fell at Huapi, and the lake and rivers were quite covered with it. At Puerto Manzano, his former residence, the ashes lay 8 to 10 inches deep, and all the cattle and the vegetation were doomed to destruction.

I submitted to analysis specimens of the ashes which he sent; they were identified as pumice. There can be no doubt that this was an important natural occurrence, far exceeding the outbursts otherwise frequent in that volcanic region; and Professor Wolf, of Heidelberg, in the Astronomische Nachrichten, loc. cit., brought the following observations into relationship with it:

La Plata, December 17, 1921 (dust clouds).
German Southwest-Africa, December 27, 1921 (nocturnal striæ).
Sonneberg, January 25, 1922 (nocturnal striæ).
Heidelberg, January 30, 1922 (nocturnal striæ).
Essen, February 3, 1922 (nocturnal striæ).

At Davos after January 21, 1922, small decreases of the radiation intensity and other optical phenomena (e. g., strong zodiacal light, comparatively strong purple light, etc.) pointed in the same direction; and one could adduce the unusual halo phenomena (*4*) observed at Ellendale, N. Dak., and New Haven, Conn., on February 12 and 25, 1922; also the two sharp peaks which are separated by a deep trough in Schmid's (Oberhelfenswil, Switzerland) curve of the circumpolar radiance (*5*) which stand out prominently from the gradual fall associated with the secular course (the trough is strongly reminiscent of that found by J. Maurer and myself on the occasion of the Katmai eruption (*6*)); furthermore, the heavy dust showers (*7*) observed in the North Atlantic Ocean from May 12 to 22, 1922; also the luminous night clouds seen at Danzig in June, 1922 (*8*). The dust clouds had evidently crossed the Equator and had reached extensive regions of the Northern Hemisphere. That they had here been productive of effects for a considerable time was not at all astonishing to the writer, for in both his extensive researches, Himmelshelligkeit, Himmelspolarisation und Sonnenintensität, 1911–1918 (*9*) and Dämmerungs- und Ringerscheinungen, 1911–1917 (*10*) and situated at a distance of about a third of the earth's circumference, he had for nearly two years, until May, 1914, been able to follow systematically the gradual decline of the Katmai eruption by a series of precise and reciprocally controlling observations of the polarization, the distribution of celestial brightness, and the intensity of the transmitted radiation in different parts of the spectrum. It may be remarked that the outburst of the Katmai Volcano is the only one not occurring in the period of greater solar activity—and whose effects were therefore not masked by those ascribable to secular variations—which has hitherto been exactly studied. And in connection with the observations referred to above, I may mention that since the same period I find the sky at Davos not nearly so sharply differentiated; the isophotes are no longer so distinctly recognizable by their different blue shades; the inner and outer disks of the solar corona are not so distinct; also, that since that time the twilight phenomena have largely diminished as regards magnificence of color.

Doctor Abbot's stations at Montezuma and Harqua Hala will probably also have been reached by these dust clouds, which seems to agree with Table 8 (loc. cit), according to which during the 6 days which followed

the volcanic eruption no observations whatever are recorded at either station, and during the next 11 days two observations only. Was the weather during just those 2½ weeks so almost unchangeably bad in both these favored regions of the world *independently of the volcanic outbreak*? If, however, any relationship exists between this absence of observations and the volcanic eruption, would it not seem probable that a large part of the considerable fall of the solar constant, which Doctor Abbot has found to have occurred precisely since that time (*11*), was feigned by the fine ashes floating in the higher regions? The secular course, however, will also, perhaps, account for a certain proportion.

After the outburst of the Katmai Volcano in 1912, be it remembered, the effect of which was rendered strongly manifest at Mount Wilson, as is, for instance, to be seen from Fowle's calculations of the dust content (*12*) (1912), 25 per cent; in June, 1913, still 2.6 per cent, against only one-half of 1 per cent in (1910–11) the quite irregular, partly very high, but also partly very low, values of the solar constant of 1912, which are now rejected in the criticisms, were followed in 1913 by a considerable sag (interrupted here and there by unusually high, narrow peaks) which led far below the minimum anticipated for the secular course for 1914–15. Professor Marvin has already drawn attention in his criticism (loc. cit., p. 286) to these "spurious variations of the solar constant as the consequence of a violent eruption."

It is sufficiently clear that a registration requiring at least seven minutes to perform, and with nonhomogeneous dust masses expelled with differing force at different times and unequally dispersed by unequal winds, will show different absorption capacity for different wave lengths; but even were the radiation to be reckoned with only that arising from the solar disk alone and traversing only the equal-dimensioned atmospheric section lying between the sun and the observer, unequal effects upon the "fundamental" quantity are to be assumed, as Professor Marvin stresses with gratifying clearness, viz, the quantity which is indicated by the pyrheliometer. But with the standard pyrheliometer, and still much less with the secondary instruments, it is not by any means the sun alone and the small part of the sky in front of it which radiates into the instruments, but a much larger part, which differs in all instruments and is often very unequally demarcated.

According to Figures 4 and 8 in volume 3, pages 53 and 64, of the Annals of the Smithsonian Astrophysical Institution, there radiates into the standard instruments ("water flow" and "water stir") in addition to the sun a circular celestial zone extending to 3° 48′ and 6° 10′ from the sun's edge; while in Marvin's pyrheliometer, according to the figure contained in the MONTHLY WEATHER REVIEW, 1919, page 769, this zone extends to about 4° 26′. With the silver disk, and similarly with Ångström's and Michelson's instrument, unequally demarcated celestial zones are effective besides the sun, which differ according to the side and altitude, and amount to a mean of 5° from the sun's edge. This radiation from the sky is by no means negligible. In the Abhandlungen d. Preuss. Meteorolog. Inst., volume 6, pages 38–44 and pages 52–54, I have investigated in different parts of the spectrum (photo-metrically and photo-electrically) the distribution of brightness and the absolute brightness of the sky in immediate proximity to the sun, above, laterally, and below, and at different solar altitudes, supporting my conclusions with numerous data and curves. On page 61 the conclusion has been reached to the effect that on the average a measuring instrument with angular aperture 7° (celestial zone of 3° 15′ from the sun's edge radiating with the sun) causes the solar brightness to appear by 1½ per cent too high, and a measuring instrument with angular aperture 20° (with radiating celestial zone 9° 45′ from the sun's edge) by even 3 per cent at a mean solar altitude; at a lower altitude of the sun the error is essentially greater. And these errors hold good for the clear, high-Alpine Davos sky; near large lowland towns, as derived from measurements undertaken at Kiel, the errors must be estimated at three or four times greater. For the total radiation such precise measurements of the decrease of brightness from sun to sky are not yet available; the errors will certainly be considerably less, but scarcely so small, even in favored situations, as to be always inappreciable by comparison with the fractional percentages to which the limits of error in measuring methods have been reduced by Doctor Abbot. When volcanic dust is floating above the sites of observation these errors will be very considerably increased, and in a different manner at different times and for different solar altitudes.

In the determination of the solar constant the pyranometer endeavors, indeed, within certain limits to overcome this deficiency. According to the MONTHLY WEATHER REVIEW, 1921, pages 651–652, the celestial area radiating upon this instrument was different in amount at different times, beginning with 19° around the sun; later less. This method is probably insufficiently precise and would perhaps be more adequately substituted by the method employed at Davos for determining the decrease of brightness from sun to sky. The latter has been recommended, besides loc. cit., in the Astr. Nachrichten, volume 209, No. 4999, August, 1919, as suitable for determining the momentarily prevailing extinction coefficient.

From the viewpoint indicated I think the pyrheliometric instruments are still capable of improvement. Instruments possessing a different angular aperture can not exhibit equal correlation factors for different solar altitudes and under different atmospheric conditions, and I think this appears to find expression in all the published comparison series, not merely of the standard instruments with each other, but also of these with the secondary instruments. I called attention to this circumstance at the meetings of the International Radiation Commission held at Davos from August 31 to September 2, 1925. The difficulty can only be avoided—and I speak from the experience of many years' construction work—by regulating with precision the direction of the solar radiation by means of the best quartz lenses in order to reduce the area of sky around the sun as much as is consistent with precise adjustment. In this respect the Davos pyrheliograph (*13*) is, so far as I am aware, the only hitherto exact, physically perfected instrument. In single measurements the amount of sky which it allows to radiate upon the sensitive thermopile is limited to within 8.4 minutes of arc from the sun's edge; for continuous registrations 47.8 minutes of arc have been allowed in order to take into account slight irregularities of the clockwork mechanism due to the considerable temperature variations in the sun and shade (e. g., from passing clouds) such as occur in the high Alpine regions. The lens also affords protection from the influence of wind and dust. If the lens is kept clean the reflection and absorption capacity are always the same.

Will it ever become possible to measure the fluctuations of the solar constant with such accuracy as Doctor

Abbot at present believes, even after having successfully eliminated all the instrumental and observational errors, as well as the influence of the variation of permeability of the terrestrial atmosphere so far as it is due to the daily and annual progress of the meteorological elements in the lower layers? From the constitution of the sun we may draw the conclusion that the radiation which it emits is subject to enormous fluctuation at every moment. Certainly the corona rays are to be rightly regarded, at least in part, as an indication of the directions in which a special abundance of cathode rays are emitted from the sun, giving rise to condensation products along their path. The sun spots allow rays to radiate directly from the photosphere quite unfiltered by the solar atmosphere, whose absorption in the long-waved ultra-violet still measurable in the earth's atmosphere amounts to approximately 52 per cent. Between sun spots, however (which must extend to at least 700 km. to become visible even in the best telescopes), and completely closed solar atmosphere, all possible transitions are to be assumed, and consequently continual variations at every single point of the sun's atmosphere. It is only a question, I think, whether it can be shown beyond question that the ever-present considerable and lively variation of the emission of rays extends to the spectral regions that are allowed to pass through the earth's atmosphere. And here the real difficulty commences. This permeability of the earth's atmosphere is in all probability very largely influenced by variations in intensity of the incident radiation, and in the sense that it decreases when the emitted solar radiation increases in intensity, because a greater incident radiation brings about greater condensations and chemical transformations in the earth's atmosphere. The simplest expression of the condensations which take place is in the extent and the brightness of the "telluric solar corona," otherwise termed the "circumpolar radiance" (circumpolarer Schein), as described in the Meteorologische Zeitschrift, 1923, page 349, by J. Maurer, following F. Schmid's observations, and as I have continuously followed (Ringerscheinungen um die Sonne, 1911–1917) (*14*) in all its subdivisions (aureole, ring, inner and outer disk) by measurement at Davos. In Table 76 (loc. cit.) are assembled day for day the data which show with scarcely an exception that in the years 1915–1917 increase in the relative number of sun spots was accompanied by increase of the ring phenomena (telluric solar corona) and diminution of the radiation intensities. There it is demonstrated that the effects make their appearance suddenly and rapidly decline, and that they are at their greatest with newly appearing sun spots or with those which suddenly undergo a great increase in size. In this work, moreover, an endeavor is made to demonstrate that, and to what extent, the differentiated light phenomena of the telluric solar corona are due to diffraction effects in exceedingly minute ice crystals (Uebercirren = supercirri) which themselves owe their origin to condensation nuclei emitted from the sun. It is further emphasized that at different situations on the earth these condensation nuclei fall in different degrees of intensity, and already at that date (February, 1917) the conclusion was deduced therefrom (p. 91) viz: "It is perhaps only possible to determine accurately the fluctuations of the solar constant when measurements are undertaken at several places (including if possible the antipodes) and when due consideration is taken of the degree of purity of the earth's atmosphere, which is apparently often variable with place and time."

But variations in the short-waved ultra-violet and cathode radiation of the sun must be effective to a still greater degree in the higher layers, where ozone arises from oxygen through their influence, than in the comparatively low atmospheric layers in which the telluric solar corona has its origin. A more profitable method, therefore, of recording the variation of the solar constant than the infinitely troublesome method employed by Doctor Abbot would perhaps be to undertake measurements in parts of the spectrum in which ozone absorbs characteristically. Such investigations should, however, be performed at the altitude of high mountains, not, as by Fabry and Buisson (*15*) with their extremely delicate but unfortunately also very intricate method, in the midst of the smoke of a large port. They will also require to be greatly simplified, should it be desired—as will presumably be necessary in the near future—to collect a great deal of material in a short time. Doctor Abbot has directed his attention to the infra-red line 10.4 μ of ozone (*16*), as had already been suggested by K. Ångström. In view of the great sensitiveness of the photo-electric cells the prospect would appear to me to be favorable if measurements were made in the analyzed light of the extreme ultra-violet. The *quartz* cells with cadmium layer brought out by me some months ago seem to possess sufficiently constant sensitiveness.

With reference to H. H. Clayton's weather forecasts (*17*), these appear to me to show, with greater certainty the more they are fulfilled, that Doctor Abbot does not measure the absolute fluctuations of the solar constant, but with them their effect upon the terrestrial atmosphere also, and particularly their effect in producing changes of its permeability. It is to be hoped that the great reward which is Doctor Abbot's due for his superhuman performances will in future lie in the preeminent importance of these predictions.

A short remark, in conclusion, remains to be made on the suitability of site of the Chilean station at Montezuma for determinations of the solar constant. Doctor Abbot was in Calama until December 14, 1921, i. e., a day prior to the great volcanic outburst, yet during the long return journey across the South American Continent he apparently heard nothing of the tremendous natural occurrence. Is this not a sign of the frequency with which volcanic eruptions occur in the South American States, and is such a country adapted for an observatory for the measurement of the solar constant?

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(*6*) Met. Zeit., 1914, 49.
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(*10*) Abhandl. d. Preuss. Met. Inst., 5: no. 5.
(*11*) Mo. Wea. Rev., 1923, 51: Figure on 0. 76.
(*12*) Smiths. Misc. Coll., 1918, no. 3.
(*13*) Met. Zeit., 1922, 304.
(*14*) Abhandl. d. Preuss. Met. Inst., 5: no. 5.
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SOLAR VARIATIONS

By H. H. CLAYTON

In the series of articles by Professor Marvin, Doctor Kimball, and Mr. Clough on the subject of solar variations in the MONTHLY WEATHER REVIEW for July and August, 1925 (vol. 53, Nos. 7 and 8), these authors analyze the work of the Smithsonian Astrophysical Observatory in regard to short period variations in solar radiation, and arrive at very discouraging views concerning the reality of these variations.

Professor Marvin says, "Unusual methods of analysis are required, because the total variation due to all causes is so small that it is entirely plausible that all of it may be nothing but errors of measurement." Doctor Kimball says, "Of the extreme range in values, which at Harqua Hala is from 1.958 to 1.871, or 0.088 gr. cal., and at Montezuma from 1.954 to 1.877 or 0.077 gr. cal., not over 0.003 gr. cal. can be attributed to some such common cause as solar variability, an amount which is quite negligible." And Mr. Clough says, "All these results point to the conclusion that if one could but wholly remove the atmosphere with all its depletions and fluctuations of intensity of transmission, and all instrumental errors, scarcely any variations of radiation intensity would remain."

Professor Marvin's article is an analysis by statistical methods of the final values of the derived solar constant published by Doctor Abbot and his collaborators. The only proper person to reply to this analysis is Doctor Abbot himself, who knows the details of his methods and his mechanism better than anyone else. In so far as my own work is concerned, I do not consider it necessary to enter into these details. No practical builder, when considering the construction of a house, would deem it essential to study botany and learn how boards grow, nor to study the details of nail-making machines before using the nails. All that he would think necessary would be to test the boards and nails in order to ascertain if they were suitable for his purpose. For such reasons I have not thought it essential to analyze Doctor Abbot's methods in detail before using his results, but rather to test these results by accepted methods and if they pass these tests to feel assured that the method of obtaining them was correct. In fact, when in 1915 I began using the measurements of solar radiation made by the Smithsonian Astrophysical Observatory, Doctor Abbot had already submitted these measurements to three crucial tests. In 1912 he established an observatory in the arid desert of northern Africa, and compared the results obtained there with those obtained simultaneously at Mount Wilson. There were large individual differences, but when the observations were massed in a single plot, it was evident that something in common was being measured at the two stations.

The next test was a comparison of the solar radiation measurements at Mount Wilson with changes in the contrast of brightness between the outer rim and the central area of the sun. For the year 1913, which was the year first used in my investigations, the correlation between the solar radiation values and the contrast of brightness between the central area and the outer rim of the sun was 0.60 ± 0.067.

A third test consisted in comparing the ratio between the intensity of the short-wave radiation and the long-wave radiation for different measured values of the total radiation. It is well known that when a body increases in temperature the proportion of short-wave radiation increases, so that the body becomes first red, then yellow, and finally blue as the temperature rises. So Doctor Abbot found that as the sun's radiation increased the proportion of short waves increased.

These three tests seemed to me convincing evidence of the reality of the solar radiation changes, and I prepared a fourth test, namely, to see if the measured solar changes were correlated in any way with atmospheric changes on the earth. A comparison was made of the solar-radiation measurements with the temperature and pressure at stations scattered all over the earth. The results showed systematic changes which seem difficult to explain on any other grounds than a real relation. When the sun was hotter, the pressure fell and the temperature rose slightly in the equatorial belt and in high northern latitudes, and changed in the opposite way in intermediate latitudes. At some of the stations the correlation was as high as 0.50 and about four times the probable error.

In 1918 a solar observatory was established at Calama, in the desert of northern Chile, and simultaneous observations were made with Mount Wilson during the months June to October, from 1918 to 1920.

In order to present the relation between these simultaneous measurements in another way, I arranged the observations at Calama in a series of steps separated by 0.010 calorie, as shown in Table I, and for each class at Calama counted the frequency with which the simultaneous values occurred in different classes at Mount Wilson. It is evident that if there were no relation the observations would be scattered through the different classes at random, while if there were a relation between the two the observations would group themselves, and this grouping would be displaced systematically.

TABLE I.—*Comparison of solar radiation measurements at Calama, Chile, and Mount Wilson, Calif., years 1918–1920*

Values at Calama	1.920-9	1.930-9	1.940-9	1.950-9	1.960-9
Simultaneous values at Mount Wilson, number—					
1.900-9	1	1	0	0	0
1.910-9	(4)	1	1	2	0
1.920-9	3	3	1	2	1
1.930-9	0	(4)	(5)	3	0
1.940-9	1	1	5	(8)	1
1.950-9	1	4	2	7	(3)
1.960-9	1	0	1	6	3
1.970-9	1	0	1	0	1

This table brings out clearly that as the solar radiation values increased from grade 1.920–9 to grade 1.960–9 at Calama there was a maximum frequency of observations near the same grades at Mount Wilson and a steady progress from low to high values. I can not see what other interpretation can be put on this relation except that the observers were measuring the same phenomenon at the two stations, and that this phenomenon showed a range from grade 1.920–9 to 1.960–9, or more than 2 per cent, of the mean solar radiation value. There was no appreciable secular change during this interval, so that the whole of this variation must have been due to short period changes. According to Doctor Abbot's computations, these simultaneous observations show a correlation of 0.49 ± 0.05.

The scatter of the observations on each side of the maximum frequency is a measure of the errors of observa-

tion, and the fact that the maxima at Mount Wilson tended to come at a slightly lower level shows that there was some constant difference in level between the two, due to calibration of the instruments or to other causes.

In order to determine the probable error of the observations, I obtained all the differences between the pairs of simultaneous observations at the two stations, 110 in all, and found that they were distributed as shown in Table II.

TABLE II.—*Distribution of the differences in solar radiation values observed simultaneously at Calama and Mount Wilson*

Mean difference, thousandths of calories	−70	−60	−50	−40	−30	−20	−10	0	10	20	30	40	50	60	70
Frequencies	1	1	0	3	4	13	23	28	14	6	4	4	0	0	3

In counting the number of observations for −10, for example, all the observations between −6 and −14 were used; for zero, all the observations between −5 and +4 were included; and for +10, all observations between +5 and +14 were taken; and so on for each grade. As the distribution of these numbers evidently follows the normal law of distribution of errors of observations, they were reduced to percentages, and a curve of best fit was drawn through them. This can be done with much accuracy by means of the "Arithmetical Probability Paper," in which the probability integral is expanded so that the plotted numbers fall along a straight line. These percentages and the normal curve of best fit are plotted in Figure 1.

From this curve the probable error of the differences is found to be ±0.0121 calorie, and since this value is made up of the combined errors of observation at Mount Wilson and Calama, the probable error at one station is $\frac{0.0121}{\sqrt{2}}$, which gives a value of ±0.0086 for the observations at one station, assuming the errors at the stations to be equal. Or if we assume, as is probable, that they were slightly larger at Mount Wilson, we may take the probable error there as ±0.009. There are other ways of determining the probable error, but I regard this method as the most accurate one. It implies that the observations are independent of each other. Any correction which served to reduce the means of the observations to the same level or the same zero on the scale of measurements used would not alter the results in a way to change the conclusion drawn from them.

I used the observations at Mount Wilson for a study of the correlation between solar radiation and temperature and pressure in Argentina and we are now in a position to determine how much error was involved. In one comparison, I took all the highest values of solar radiation between the years 1909 and 1918, and determined the averages of the solar radiation values for each of the 30 days following the high solar radiation values, and for five days preceding. The number of cases varied somewhat, but averaged about 35. I then obtained averages of the temperature for each of the corresponding days at Buenos Aires. These means, after allowing an interval of three days for a lag in the effect, showed a correlation of 0.66 with the means of solar radiation. The mean values of solar radiation ranged from 1.930 to 1.952, while the probable error of the differences between the pairs of observations is

$$\pm\frac{0.0121}{\sqrt{35}}=\pm 00.021.$$

The observed range is hence 10 times the probable error of the means. This, it seems to me, is sufficient evidence that I was dealing with real solar changes and that the correlation is a real one.

In another case, I correlated 10-day means of solar radiation with 10-day means of temperature at various stations in Argentina, and obtained correlations exceeding 0.80 between the mean temperatures and the mean solar radiation values. The range in the mean values of solar radiation in this case is 0.032 gram calorie, and the probable error is

$$\pm\frac{0.0121}{\sqrt{10}}=0.0037.$$

Here the observed range in mean values is about nine times the estimated probable error of the pairs of values; but this is somewhat too great, because there were some gaps in the solar radiation observations. Allowing for these, the range is about seven times the probable error of the means. Here again it is evident that I was dealing with real solar changes and that the correlations are real.

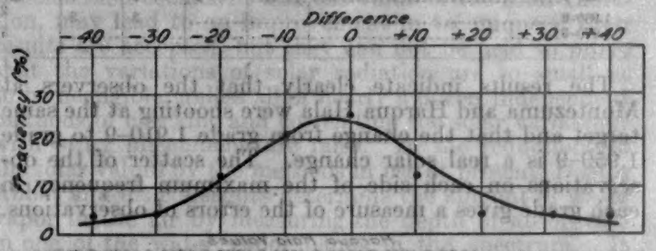

FIG. 1.—Distribution of the differences between the values of solar radiation measured simultaneously at Calama and Mount Wilson (unit .001 gram calorie per minute)

Turning to the more recent measurements at Montezuma, in northern Chile, and Harqua Hala, in Arizona, for the interval April 1922 to November 1924, I have counted from the dot diagram of Doctor Kimball in the July, 1925, MONTHLY WEATHER REVIEW, the number of observations in each grade at Harqua Hala between the successive values at Montezuma of 1.890, 1.900, 1.910, etc. The results are shown in Table III.

TABLE III.—*Comparison of the numbers of simultaneous solar radiation measurements in each grade, at Montezuma and Harqua Hala, years 1922–1924*

Values at Montezuma	1.890-9	1.900-9	1.910-9	1.920-9	1.930-9
Values at Harqua Hala:					
1.880-9	1				
1.890-9	(3)	4		6	1
1.900-9	0	4	11	11	2
1.910-9	2	7	(20)	21	10
1.920-9	1	(11)	19	(34)	19
1.930-9	2	4	10	10	(24)
1.940-9		1	5	6	11
1.950-9				1	3

Here again we see that when observations were made in one grade at Montezuma there was a maximum frequency in the same grade at Harqua Hala. The only exception to this is in grade 1.900–9. I can see but one explanation of this progressive sequence in the maximum frequencies at Harqua Hala with increasing values at Montezuma, and that is that both observers were measuring solar radiation values which progressed from grade 1.890–9 to grade 1.930–9. This range is over 2 per cent of the mean solar value. If we drop grades 1.890–9 and 1.900–9, there still remains a progressive change from grade 1.910–9 to grade 1.930–9 of over 1

per cent. Yet for this same interval Doctor Kimball's analysis leads him to assert that not over 0.003 gram calorie can be attributed to some common cause as solar radiation.

If we take all the simultaneous observations represented in Doctor Kimball's diagrams for the interval from October, 1920, to November, 1924, the simultaneous occurrence of the maximum frequency in the same grades from grade 1.910–9 to grade 1.950–9 is very clear. These frequencies for the different grades are shown in Table IV.

TABLE IV.—*Comparison of the numbers of simultaneous solar radiation measurements in each grade at Montezuma and Harqua Hala, years 1920–1924*

Values at Montezuma	1.910-9	1.920-9	1.930-9	1.940-9	1.950-9
Values at Harqua Hala:					
1.890-9		2	2		
1.900-9		6	1		
1.910-9	11	11	2		
1.920-9	(31)	21	11		
1.930-9	19	(37)	20	5	
1.940-9	10	23	(28)	4	7
1.950-9	6	6	14	(11)	(8)
1.960-9		1	9	7	2
1.970-9			3	3	3

The results indicate clearly that the observers at Montezuma and Harqua Hala were shooting at the same target and that the change from grade 1.910–9 to grade 1.950–9 is a real solar change. The scatter of the observations on each side of the maximum frequency in each grade gives a measure of the errors of observations.

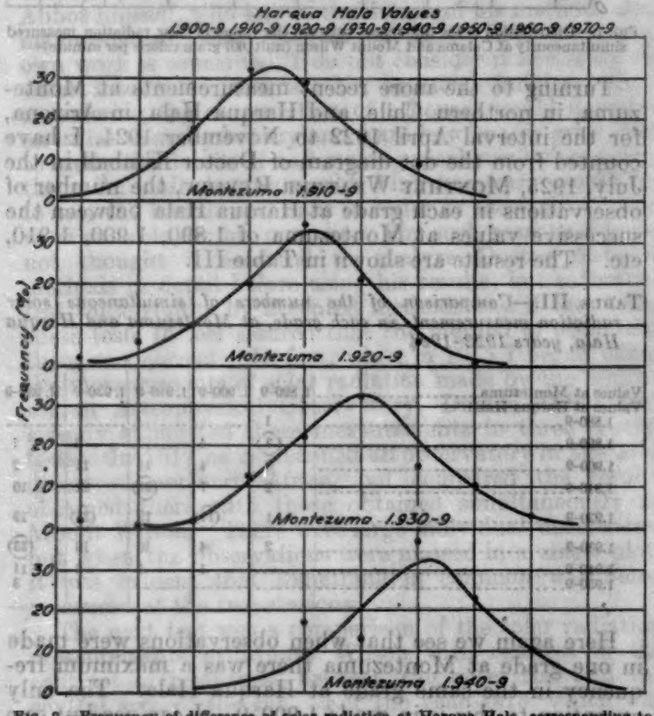

FIG. 2.—Frequency of difference of solar radiation at Harqua Hala, corresponding to simultaneous observations at Montezuma, 1920–1924, taken in grades differing by .010 calorie

The observations are sufficiently numerous in the four grades from 1.910–9 to 1.940–9 to permit an estimate of the probable error of the measurements in each grade. The frequencies were reduced to percentages and plotted on straight line probability paper. From these plots the probable error of the measurements in each grade was determined as follows: Grade 1.910–9, ± 0.0082; grade 1.920–9, ± 0.0080; grade 1.930–9, ± 0.0093; and grade 1.940–9, ± 0.0087. These probable errors are for the combined errors at the two stations. In order to obtain the probable error of the individual measurements at a single station, it is necessary to divide by $\sqrt{2}$. This gives a minimum value of ± 0.0057 for grade 1.920–9 and a maximum value of ± 0.0066 for grade 1.930–9. These four independent determinations are thus very accordant in showing a range of 0.040 gram calorie in the solar radiation, and a probable error of ± 0.006 gram calorie in the individual measurements. A plot of the percentages in each grade and of the curves of best fit are shown in Figure 2.

The question arises, Why did Doctor Kimball arrive at such a different result? There are, I think, two reasons. In the first place, Doctor Kimball broke up the period of observation into three parts, reducing the range of the solar variations, while the errors of measurement remained constant. To any one who has studied the method of correlation, it is evident that correlation coefficients are greatly reduced by such a proceeding, and may be reduced to almost zero by restraining the range of the phenomena measured within sufficiently narrow limits. Secondly, Doctor Kimball assumes that a small correlation coefficient proves that there is no relation between the phenomena compared. This assumption is, I think, erroneous, although it is frequently made.

Some years ago a case was brought to my attention, where the run-off of a river showed no correlation with the rainfall in the watershed of the river. By the methods of computation used by Professor Kimball it might have been shown that there was an insignificant relation between the two. This seemed to me an improbable conclusion, and when I looked into the matter I found that the river was fed by two nearly equal branches, in one of which there was a relatively steep descent and the water from the rainfall was fed quickly into the main stream, while in the other branch it was fed more slowly, so that the two flows tended to neutralize each other and produced the result mentioned. The whole of the variations in the main river was undoubtedly due to the rainfall, and yet by the usual methods of treating two results, they showed no correlation. The point I wish to bring out is that high correlations undoubtedly show close relation between phenomena, but low correlation does not prove that there is no intimate connection between the two, as many persons assume.

In addition to the evidences of solar variability which I have already recited, I have found that in the average of 200 cases that there is a sharp maximum of solar radiation coinciding with the times of maxima of faculae on the sun,* using for this study the observations published by the Greenwich Observatory. For the months of April to September there were 121 observed cases and the mean maximum value varied from the mean values of preceding and following days to the extent of nine times the probable error of the mean.

I found also that there was a marked depression of solar radiation when sunspots and their attendant faculae crossed the central area of the sun. In this case the depression of the mean solar radiation below the mean of the values obtained when the spots were near the limb of the sun was seven times the probable error of the means.

*See Smithsonian Miscellaneous Collections, vol. 77, No. 6.

Fowle has recently shown that there is a similar relation to the position of flocculi.

Further evidence of solar variability is furnished by the high correlations I have found between solar radiation values and certain atmospheric conditions in various parts of the world, which are published in the Smithsonian Miscellaneous Collections and elsewhere. Similar evidence is furnished by the work of others. From seven-day means of the pressure differences between Christiania and Bergen and of solar radiation, Helland-Hansen and Nansen found a correlation coefficient of 0.63 between the two for the period from June 8 to September 6, 1915.

These correlations are too numerous and too high to be dismissed as mere chance. It is true that other comparisons, even at the same places, give small correlation between the solar radiation and meteorological conditions, but as explained above, small correlations do not necessarily imply no relation, and do not offset large correlations. There are many reasons for the smaller correlations. The first is the inaccuracy of the solar measurements. The measurements may be fairly exact for a while under favorable observing conditions, and then be exact under less favorable conditions. In such a case high correlation with atmospheric changes might be followed by low correlations. Again, it is evident that waves of atmospheric change set up by solar changes travel from place to place and are superposed on waves of changes originating in other centers. After a period of solar quiet an increased activity might show a high correlation with certain regions, to be followed later by a low correlation as waves of change came in from other regions, and yet the whole effect be due to changes in solar radiation. In such cases low correlation does not disprove solar relations.

But the evidence of correlation of changes at individual stations with solar changes is not the whole story; there is evidence of an orderliness in the relations over the world as a whole, which is utterly inconsistent with chance agreement. In the equatorial region and especially in the region extending from the Amazon across the Atlantic, Africa, the Indian and the western part of the Pacific Oceans, a fall of pressure accompanies increased solar activity whether we take years of increased radiation, months having high average values, or individual days of large values, and obtain an average. Furthermore, the pressure increases in intermediate latitudes, and finally this belt of increased pressure sways back and forth toward and away from the Equator in unison with the increase and decrease of solar radiation. This swaying toward and away from the Equator is clearly shown in the United States from the average of a large number of individual days of high, medium, and low solar radiation as well as from monthly and annual means.

There are two points in Professor Marvin's paper to which I feel I should reply. Professor Marvin has long felt that a change in solar radiation of one per cent or less is too small to produce any appreciable meteorological change. In considering questions like this one, it should be borne in mind that large and small have no absolute value, but are merely comparative. A thing may be very small from one point of view and very large from another. A tidal wave, for example, might be extremely small as compared to the great Atlantic, not having a breadth, let us say, of more than one-ten-thousandth part of the width of the great ocean, nor a vertical height of more than one thousandth part of the depth of the ocean, and yet it might have the power to wipe out or seriously damage every city along the Atlantic coast, and thus be of the greatest importance in human affairs. It seems to me that the only way one can determine whether an observed change is important or not is to test it by comparison with the facts of nature.

That the range of the measured fluctuations of solar radiation should decrease with increasing refinement of the measurements is only what should be expected and by no means warrants a conclusion that the solar variations will cease with further refinements in the measurements.

The second point is in regard to the annual period in the solar radiation values claimed by Professor Marvin. If there exists a small annual period in solar radiation measurements, it would not materially affect the results of my investigation, because in investigating the relation between solar and meteorological changes I have in general separated the seasons and compared only the observations made at the same season.

The analysis of the methods of measuring solar radiation by Professor Marvin, and the interesting discovery by Mr. Clough of a correlation between the atmospheric transmission coefficient and the value of the solar radiation, may lead to an improvement in technique if their results are accepted, but they can not be held to prove that the variations of solar radiation are so small as to be negligible, unless all of nearly a dozen independent methods of checking and correlating the solar variability with other phenomena are false. In the reductions of the solar values by the methods in use at present, Doctor Abbot and his colleagues determine the amount of water vapor in the air by measuring the depth of absorption in one of the water vapor bands in the spectrum. It may be that these measurements were not of sufficient accuracy to eliminate the total effect of the water vapor. If so, that would explain the fact claimed by Mr. Clough that the solar radiation values changed in unison with changes in the water vapor content and the transparency of the air, and also explain the annual period in the intensity claimed by Professor Marvin.

SUMMARY

My conclusions are (1) That the comparison of simultaneous observations taken at Mount Wilson and Calama and later at Montezuma and Harqua Hala show that the derived values of solar radiation varied repeatedly between the values 1.910 and 1.960, and that the extreme range must have been considerably greater. A part of this change was due to a long period secular change, but the larger part was due to short period changes, especially during the interval July, 1918 to September, 1920.

(2) That the probable error of the individual observations at Mount Wilson is about ± 0.009 gram calorie, and at Montezuma less than ± 0.006 gram calorie.

For groups of values such as I used in my investigations the mean errors were equal to $\frac{\epsilon}{\sqrt{n}}$, in which ϵ represents the probable error of the individual observation and n is the number of observations in the groups.

DISCUSSION OF THE FOREGOING PAPERS

By C. F. MARVIN, H. H. KIMBALL and E. W. WOOLARD

In the foregoing paper by Mr. Clayton, he declines, perhaps naturally, to discuss the analyses of Smithsonian solar constant values by members of the Weather Bureau staff, as published in this REVIEW for July and August, 1925. Since he holds that his researches are not concerned with the solar constant determinations except

as tools to be used in the work, he believes that Doctor Abbot is the one to deal with the bureau's findings. His paper is therefore in fact simply a restatement of views published in his earlier papers, especially "Solar Radiation and the Weather," in Smiths. Miscell. Coll. vol. 77, no. 6.

The question raised by the Weather Bureau has always been, in effect, are Doctor Abbot's remarkably refined determinations of the solar constant proper tools with which to forge a weather forecast? Our analysis has convinced us they are not. Mr. Clayton believes they are.

Doctor Abbot's annual report for 1925 as director of the Astrophysical Observatory, recently issued, contains statements which seem to remove at least the fundamental differences of view concerning the determinations which form the subject of this whole question. On page 103 he says:

> The investigations hitherto made having indicated that a higher degree of accuracy in our solar measurements is needed to supply proper data for forecasting purposes, a very great deal of attention has been given to the elimination of small sources of error in the observations and reductions of solar radiation. Already the average deviation of individual days' results between Chile and Arizona is but one-half per cent. It follows that in order to obtain higher accuracy we shall be obliged to regard sources of error which formerly we supposed would always be negligible.

It seems that this statement by Doctor Abbot essentially confirms the general correctness of the results brought to light by our investigations of the derived values of the solar constant as published by the Astrophysical Observatory. Our view has been, and is, simply that the day-to-day variation of these values, due to all causes, as derived from the very best observations, became smaller and smaller as improvements of methods and places of observations were effected. Clearly, if the sun were the chief cause of the fluctuations, improving the methods would reduce the fluctuations only slightly. We find that the total variation due to all causes is of an order of magnitude of one-half of 1 per cent and less, according to the observations selected.

Now, it will be noticed that Doctor Abbot places the average deviation between Chile and Arizona at but one-half of 1 per cent. Our one-half of 1 per cent includes not only all errors, both instrumental and atmospheric, but also the real solar changes if there are any. Doctor Abbot's one-half of 1 per cent excludes solar changes and depends solely on the errors at the two stations. It can be shown that the significance of the close agreement of our results arrived at by two different methods is not lessened in any material degree by the fact that slightly different statistical units for measuring variability were employed in the two cases.

In my article in the REVIEW for July, page 303, Table 7, it was indicated that so far as it could be mathematically determined from observations available, the part of the total variation that might be ascribed to other than terrestrial origin, again from the best observations, ranged between 0.15 and 0.30 per cent. From the paragraph quoted above, I do not understand that Doctor Abbot differs essentially from these findings. In other words, the magnitude of the possible short-time variability of solar radiation considered as a whole is, as shown by the best observations, of the order of one-fourth of 1 per cent.

Can one-fourth of 1 per cent of variability be a safe basis of forecasting the weather for short or long periods in advance? It is universally agreed that all aspects of weather are due solely to atmospheric interceptions, by conduction to the atmosphere and its absorption of incoming and outgoing solar and earth heat respectively. If there were no interception or absorption of solar heat of any kind, weather as we know it would not exist. Now, supposing the total output of radiation does fluctuate one-fourth of 1 per cent, does not Mr. Clayton seriously disregard the question of the quantitative sufficiency of cause and effect, when he holds, as he seems to, that our weather phenomena can be primarily caused by, or forecast on the basis of, so small a fluctuation?

In this connection, reverting again to the seemingly close accord between the Smithsonian Institution and the Weather Bureau as to the basic fact concerning the average amount of possible solar fluctuations, I wish to quote a passage from an article by Doctor Abbot in the National Geographic Magazine for January, 1926, beginning on page 111, as a statement of at least one view he and Mr. Clayton hold regarding the cause and effect relations of very small solar fluctuations and the weather:

> The fact is we have discovered that the sun is a variable star. Mr. H. H. Clayton, the eminent American meteorologist who has been cooperating in the work, has proved that very distinct changes of barometer, temperature, and rainfall are caused by these changes and the intensity of sun rays. He even goes so far as to say that he more and more believes, as his studies progress and bring new facts to light, that all that we call weather—symbol for all that is variable, in distinction to climate, which is the steady, average condition of things—is really due to the sun's variation.
>
> This seems a bold claim. We shall see presently how he supports the claim. What interests us still more is that he finds it possible to predict weather for days, weeks, and even a month in advance, just by using observations of the sun's radiation and its changes.
>
> The astonishing feature about his results is that very small solar changes, even those of less than one-half of 1 per cent, in the sun's radiation are able to produce considerable changes in the weather. This seems at first rather preposterous. We think of night and day, with 100 per cent change from light to darkness, and of the great change of intensity of the sun's rays between summer and winter. Neither of these tremendous changes of solar radiation gives tremendous changes of temperature.
>
> We must forego possible explanations of Clayton's paradox, merely remarking that a small pull of a pistol trigger can do great damage; and something analogous may be involved here

The answer the Weather Bureau must make to the "trigger" suggestion is that the idea is idle speculation, at least until Doctor Abbot or Mr. Clayton gives some physical or observational evidence of the catalytic involved. Assuming that the solar output, considered as a whole, fluctuates from day to day by one-fourth of 1 per cent there is nothing in our present knowledge of the subject to cause us to expect that the effect on the weather would be other than at least approximately of the same order of magnitude.

We are particularly fortunate in being able to publish in this REVIEW an excellent paper on "Fluctuations in the Values of the Solar Constant" by Dr. C. Dorno. The writer is glad to learn Doctor Dorno's views because they very fully confirm the conclusions reached at the Weather Bureau from purely statistical analyses of the observations themselves.

There are several reasons for the failure of the Weather Bureau to call attention to the volcanic eruption in the southern Andes in December, 1921, as a possible cause of the decided change in solar constant after March of 1922. Our attention was confined exclusively to the search for statistical evidence as to the *magnitude of the total short-period fluctuations* and what part of them one might be justified in ascribing to true solar origin. We have made clear in previous papers our belief that all of the now very small total fluctuations may well be due to instrumental and atmospheric influences. Moreover, and this is highly important, serious instrumental difficulties

developed at the Montezuma station in 1922 which the local observers were unable to overcome. All the observations from August of 1920 are provisional values only, and Dr. Abbot has stated that they will be entirely revised and republished in the near future.

Doctor Dorno is entirely correct in calling attention to the possibility that volcanic dust may have been one cause of the general lowering of the solar constant values during 1922. We hesitate to believe, however, that it is an adequate explanation of their continuance at this low level well into 1924. What effects are we to expect volcanic dust would produce upon properly derived values of the solar constant? Obviously none, if our measurements and their extrapolation to zero air mass are correctly done, because dust in our atmosphere can not change the intensity of solar radiation outside of the atmosphere. The principal effect of the Katmai dust was to cause large fluctuations between individual daily values as determined by the bolograph, accompanied by a lesser effect on the average measured intensity, which was, however, slightly lowered. Now, while we do find some increase in daily variability in 1922, which died away within a few months, the major feature is a conspicuous general lowering of intensity. During this period, nearly all observations were made with the pyranometer, a highly empirical instrument, whose behavior in contrast with that of the bolograph must be reckoned with in the interpretation of the apparent general lowering of intensity just mentioned. Doctor Abbot himself well says "a higher degree of accuracy in our solar measurements is needed."

In the light of experience, how is anyone to tell from the fluctuations of the derived values of the solar constant what were the true changes of intensity of the total radiation? Indeed, may it not be that we are approaching the point where it will be necessary to look beyond changes in intensity of the total radiation to changes in restricted spectral regions, if we would discover relations between solar radiation and the ever changing conditions of the earth's atmosphere? Doctor Dorno stresses the importance of the problem of the ultraviolet radiation, its nature, distribution in wave length, fluctuation in amount, as well as its possible meteorological effects. Doctor Abbot himself, in his 1925 Annual Report of the Astrophysical Observatory, page 104, says that "the importance of studies of the variation of the sun's output of ultraviolet rays grows upon our attention." Moreover, the results of Dr. Edison Pettit's work at Mount Wilson on the ultraviolet radiation of the sun seem to indicate that variations in intensity in this region of the spectrum are very great. (Carnegie Institution of Washington, Yearbook no. 24: 101–102.) We must not, however, overlook the serious difficulty encountered in attempting to allow correctly for the great effects the atmosphere exerts even under the most favorable conditions, upon the relatively feeble short and extreme ultraviolet radiations.

If the meteorological effects of these radiations are purely thermodynamic in character, we can not expect knowledge of their amount and flunctuation to aid materially in weather forecasting, because their total thermal intensity is but a small fraction of the whole. On the other hand, the physical phenomena associated with them are of great importance, justifying every possible effort to their full investigation. It may even be possible that some of the physical changes due to ultraviolet radiation in turn affect the thermodynamic behavior of the air in a way and to a degree that are of meteorological significance.

In conclusion, I wish to subscribe cordially to Doctor Dorno's comments upon the pyrheliometer as a fundamental and basic instrument whose refinement to a higher order of accuracy is important.—*C. F. Marvin.*

The first part of Clayton's paper may be passed over without comment since, as Whipple points out (*1*), it relates to data which Doctor Abbot has rated as either "ancient" or "medieval" (*2*). His discussion of more recent measurements at Montezuma and Harqua Hala, which Doctor Abbot rates as "modern" (*2*) requires consideration, for the reason that his method of analysis brings him to a result that is not in accord with the conclusions to which I was lead by a different method of analysis (*3*). His effort to harmonize our differences seems to me to lead to quite unsatisfactory results.

In my own analysis I separated the 398 pairs of solar constant values obtained at Montezuma and Harqua Hala between October, 1920, and November, 1924, chronologically into three groups. The first group contained 99 pairs of values, the mean of which is 1.945; the second and third groups 106 and 193 values, respectively, the mean value within each of these groups being 1.922. The correlation coefficients for the different groups is as follows: first group, $+0.341 \pm 0.060$; second, $+0.18 \pm 0.063$; third, $+0.17 \pm 0.045$.

Clayton arranged the same pairs of observations so that the Montezuma values were separated by steps of 0.010 calorie, and for each class at Montezuma counted the frequency with which the simultaneous values occurred at Harqua Hala. In his analysis, however, he considered only the 53 pairs of values corresponding at Montezuma to grade 1.910–9, the 81 pairs corresponding to grade 1.920–9, the 66 pairs corresponding to grade 1.930–9, and the 44 pairs corresponding to grade 1.940–9, making 244 pairs in all, discarding all extremely high and extremely low values. He then computed the probable error of each of the four classes, finding it to be in each case approximately ± 0.006 calorie. Hence it is that our analyses lead to such different results. Clayton assumes that all of the 0.040 gram-calories in the range of the values in the four classes, except the probable error, is due to solar variability, and compares this 0.040 ± 0.006 with the solar variability I obtain through the squares of my correlation coefficients, namely, 0.014 for the period October, 1920, to March, 1922, inclusive, and 0.003 for the period April, 1922, to November, 1924.

Attention is drawn to the fact that Clayton presented no correlation coefficients in this connection. Furthermore, his method of analysis includes all the secular variation in the solar constant values between October, 1920, and November, 1924, while my method excludes the difference between the mean values of the two periods named above, or 0.023 calorie out of the 0.040 calorie claimed by Clayton. In my paper I referred to the fact that a higher value of the correlation coefficient between the two stations would have been found had I included all the observations in one group. My object, however, was to determine the correlation coefficient between day-to-day values of the solar constant at the two stations, excluding, as far as possible, secular variations.

With reference to the significance of correlation coefficients I quoted authority (*4*) which, so far as I am aware, no one has yet questioned.

The remainder of Clayton's paper is devoted principally to a discussion of correlations between solar constant values and sun spots and weather changes, with reference

to which we may again quote Whipple as follows (*1*): "There is no attempt to show that the results are not attributable to chance, and, indeed, the general run of the graphs is in accordance with the hypothesis that they are."

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—*H. H. Kimball.*

In the investigation of any problem by the method of correlation, the real work does not begin until after the coefficient has been computed and its probable error determined. Even after everything possible has been done to insure against errors due to the nature of the data used, possible nonlinear regression, etc., there still remain numerous considerations which must be taken into account in addition to the mere face value of the coefficient; the difficulties in the way of arriving at conclusions which can be trusted, and the pitfalls awaiting, are numerous.

The problem quoted by Clayton on page 524, e. g., illustrates the following particular points: The correlation coefficient by itself is not an index to physical cause and effect, but merely an index of concomitant variations, however these may be brought about (the true measure of the degree of this relationship is the *square* of the coefficient). Where we know a relationship must exist, the computation of the coefficient and the derivation of the regression "equation" serve the purpose of providing a quantitative expression of the relation, from which more or less useful predictions may be made; but in any case, while revealing to what extent fluctuations in one quantity are accompanied by proportionate fluctuations in another, the coefficient throws no light on the causal mechanism connecting the two.

The gross coefficient may result from the action of a third influence affecting each of the two variables correlated; or the mechanism may be of a much more complicated character. In Clayton's example, fluctuations of run-off did not accompany fluctuations in rainfall over the watershed, and the zero correlation reflected this fact; and as long as knowledge was confined to these two things, rainfall could not be used to predict run-off—these two variables are mathematically independent. So, if a large coefficient had been found, it would not have proved rainfall and run-off to be causally connected (though, in this case, considerations external to statistics would have suggested this as the common sense interpretation); but nevertheless, a knowledge of one would have enabled calculations of the other to be made, since they would vary together, for some reason or other. The tracing of relations of cause and effect, and the interpretation of gross coefficients, as well as the improvement of the regression equations, involves the computation in many cases, of net (partial) and total coefficients also.

Caution must always be exercised in applying the customary formulas and criteria to small samples, for they do not then always hold. Attention should also be invited to Walker's discussion of the criteria for the reality of correlation coefficients, Mem. Ind. Met'l Dept., vol. 21, pt. ix, pp. 13-15, 1914.—*Edgar W. Woolard.*

MONTHLY PRESSURE VARIATIONS IN THE NORTHERN HEMISPHERE AND SEASONAL WEATHER FORECASTING

By ALFRED J. HENRY

SYNOPSIS

The variations of monthly mean pressure for stations in the Northern Hemisphere, as published in Reseau Mondial for the eight years 1910-1917 were studied with a view of determining the frequency, geographic extent, and distribution in latitude and longitude of the pressure anomalies in the Northern Hemisphere for that period. The isanomalies for 67 months out of the 96 that were available were charted and studied. Many of these were featureless in the sense that the amplitude of the anomaly was small and frequently in an opposite sense in closely adjacent regions. In about 10 per cent of the cases considered the anomalies were pronounced both as to amplitude and extent of area involved These are described in some detail, and the relation of the anomalies to current and subsequent weather in contiguous areas is discussed.

The paper closes with a brief review of the method of seasonal forecasting now practiced in India and tentative suggestions are given looking to the development of a method of seasonal forecasting for the United States.

Variations from normal pressure.—The air pressure at any given place is conditioned by several separate and distinct causes, viz (*a*) the intensity of incoming and outgoing radiation of which the incoming solar radiation is by far the most important; strong outward radiation from the atmosphere and the earth causes the air temperature to fall, the air mass to contract, sink, and thus the opportunity for the inflow of fresh accretions of air aloft and a raise in pressure is brought about; (*b*) the rotation of the earth on its axis modifies the speed and direction of air motion, causes it to be heaped up in places and set in swift motion at others whereby the pressure is elevated at the one and lowered at the other. The third or (*c*) class of pressure variations which form the subject of this paper are due to a combination of the two causes above enumerated, in combination with those associated with the origin and movement of cyclones and anticyclones.

In general, monthly mean pressure for any given place will depart, more or less, from the normal in proportion to the frequency of cyclonic and anticyclonic systems experienced at the given place.

Class (c) variations.—In their simplest form these variations are experienced in the paths of areas of low pressure (cyclonic systems), the amplitude being greatest at and near the center and diminishing thence in all directions. It is perhaps needless to say that pressure falls with the approach of a cyclone and rises approximately as the center of the disturbance crosses the meridian of the observing station. If then more than the normal number of cyclones for the season pass over or near to the station the monthly mean pressure will, as a rule, be less than normal and the magnitude of the departure will be an index of the frequency of cyclonic systems passing over or near the station. Likewise a large number of anticyclonic systems passing over a station or lingering over it an unusually long time will result in a positive departure from the normal. Small departures either above or below normal are, as a rule of little significance.

Amplitude of the variations.—It is a matter of common knowledge that the amplitude of the variations under discussion increases with the latitude and reach a maxi-

mum in the cold months. I have however, computed the eight-year average for eight stations in the tropics, and find that the average variation, regardless of sign is 1.0 mb. for December, January, and February, diminishing to a minimum of 0.7 mb. In April, September, and October. The mean variation in winter, in high latitudes, apparently may be as much as plus or minus 6 to 8 mb. and a single monthly variation of plus 34.1 mb. was registered at Dawson, Yukon T. in December, 1917.

As Hann pointed out some years ago the maximum day-to-day pressure variations occur over the oceans and the minimum over the land.

Frequency of variations of ±5 mb.—The maximum frequency of variations of the magnitude of ±5 mb. or greater, is in the zone of 60° to 70° in the Northern Hemisphere and quite probably the same holds true for the Southern Hemisphere. Positive and negative anomalies occur about equally on the average of the year, but some years are much richer than others in the number of positive or negative anomalies, thus 1912, 1915, and 1917 were unusually rich in positive anomalies, while 1913 and 1914 were fruitful in negative anomalies.

In all 67 charts have been made from the published data of the Reseau Mondial; many of them are featureless in the sense that the amplitude of the anomalies is small and irregularly distributed.

The following comments of a general nature are suggested by a study of the charts. Variations of large amplitude and wide extent seem to build up gradually to a maximum and then sometimes slowly, sometimes quickly disappear. Positive anomalies disappear much more quickly than negative. This may be ascribed to the fact that a positive anomaly may be thought of as a heaping up of cold dense air which naturally gravitates equatorward and therefore is constantly being deprived of its original frigidity. It contains within itself the seeds of destruction. On the other hand the large and enduring negative anomalies arise in or close to the great circumpolar whirl in certain parts of which surface conditions of temperature and moisture prevail greatly in excess of those due to the latitude; the low pressure thus originating is maintained in part by the absorption of fresh cyclonic systems which are often fed into the original low pressure system for weeks at a time, and in part by the centrifugal force of the general circulation in the polar region.

These great pressure anomalies do not seem to have the attributes of a separate and distinct entity but are similar to statistical [1] cyclones and anticyclones. That they have an apparent movement from place to place is obvious; that movement however, is apparent rather than real, in many cases the apparent shifting of the geographic position of the center of the anomaly—the region of greatest departure—can be explained by the fact that a relatively larger rise in pressure has taken place in one part of the original anomaly than in other parts, thus the center of the anomaly is automatically displaced in one direction or another.

The great negative anomalies apparently arise more readily over the sea than the land. The Mediterranean and the seas to the eastward may be the contributing influence that produces large negative anomalies in that part of Europe when such is not the case for the corresponding latitudes in North America.

[1] The word statistical is used in the sense adopted by English meteorologists in recent publications in referring to the Iceland "cyclone" and others of the same nature. The present writer would go farther and use the word to connote those semipermanent anticyclones that have hitherto masqueraded under the highly respectable, though inappropriate term "action centers."

Discussion of individual months.—Only about 10 per cent of the charts made show pronounced anomalies; these will be discussed on the pages following:

November, 1910.—This month was characterized by high pressure in the Arctic Basin and adjacent parts of America and Eurasia, also over parts of the Pacific; the greatest excess was experienced over the west Greenland coast (20 mb.) The high pressure extended from the Labrador coast in a direction a little north of east by way of Greenland, Iceland and Russia to western Siberia or about half way around the globe. Paralleling the southern margin of the region of high pressure and in a zone about equal in length pressure was below normal by as much as 9 to 12 mb. in northwestern Europe and in the vicinity of St. Johns, Newfoundland.

In the following month this great excess of pressure in the polar basin had practically disappeared, although remnants of the midlatitude deficit remained.

In the United States the month was one of deficient precipitation with temperature below normal east of the Rockies and above normal west thereof. The low temperature in eastern districts as also the dry weather may be attributed in part at least to the great depression of the barometer in the North Atlantic in the vicinity of the Canadian Maritime Provinces.

January, 1914.—In this month pressure was below normal over the greater portion, if not the whole, of the polar basin and, indeed, over large parts of the continental areas adjacent thereto. In North America there were two centers of maximum depression, the eastern one in the vicinity of St. Johns, Newfoundland, and the western one at Prince Rupert on the British Columbia coast; in intermediate regions, particularly along the 50th parallel of north latitude, pressure was also much below normal. In the Eurasian continent the principal depression amounted to close to 20 mb. in northern Russia, decreasing thence to 10 mb. in central and northeastern Siberia.

The beginnings of this great depression may be traced back to October, 1913. In that month a very considerable depression of the barometer appeared in southern Russia and a lesser one over the eastern Atlantic at the Azores. In November, 1913, two centers of depression appeared almost on opposite sides of the globe, the first and greatest in geographic extent being centered over Iceland and the second over Alaska; smaller depressions appeared over Asia, thus indicating a general weakening of the circulation over that continent. December, 1913, was characterized by a single very large area of diminished pressure that stretched from Spitzbergen to the Caspian Sea and beyond, and two areas on the North American continent, which in the light of more complete observations may have been but a single area that extended from Greenland across British North America to Alaska. Hence it is clear that the January, 1914, depression did not come into being suddenly but was a gradual development beginning three months earlier.

Having reached its maximum in January its subsequent history is one of gradual degradation both in the amplitude of the variations and in the extent of territory affected. Two months later, in March, 1914, high pressure had overspread the North American continent, including the Aleutians and most likely a portion of the North Pacific; pressure remained low, however, over the greater part of the Eurasian continent in March. In the following month high pressure from the Atlantic spread eastward over middle Europe.

The geographic center of diminished pressure, by which is meant the region over which the greatest fall occurred, did not have any progressive movement.

The depression of the barometer in January, 1914, above described, was due to the passage of a chain of cyclonic systems of Pacific origin across North America in about 50° north latitude, as is clearly shown by the weather charts for the Northern Hemisphere published in 1914 by the United States Weather Bureau. These maps show also that cyclones of Gulf of Mexico origin moved to the northeast over eastern United States and thus augmented the flow of cyclonic storms from the Pacific; these storms continued across the Atlantic and over a large part of the Eurasian continent. A positive anomaly of considerable magnitude overspread the British Isles, and thus the cyclonic storms were shunted farther toward the Arctic regions than is usual. While the flow of cyclones around the pole during this month was occasionally interrupted by the intrusion of an anticyclone, such interruptions were few.

Weather in United States.—Temperature in the United States and Canada was exceptionally high for a winter month; precipitation was deficient in the Gulf States and in excess on the Pacific coast and snowfall was generally light.

December, 1915.—In this month a large belt or zone of low pressure in latitudes 35° to 50° north almost encircled the globe. Pressure was lowest over the North Atlantic from the Canadian

Maritime Provinces to the British Isles, thence along the 50th parallel to the Kamchatkan Peninsula and probably to the Alaskan coast; pressure was also low over the North American continent. On the polar side of this great depression there was a single rather restricted region of positive pressure departures centered between Iceland and the east Greenland coast (12.9 mb.).

Weather in United States.—The month was characterized by a movement of anticyclones from the Pacific rather than from Canada, consequently temperature was mostly above the average and precipitation was also greater than normal. In eastern sections temperature was below normal, due doubtless to the area of negative pressure anomaly over the Atlantic. The immediate sequence in pressure distribution is described in the next following paragraph. Instead of a single region of strong positive anomaly as in December, 1915, there were at least two; the first occupied the North Atlantic, northern Africa, and the western Mediterranean the second occupied Alaska, extending thence southeastward to the United States and thence to the North Atlantic.

January, 1916.—This month was characterized in the United States by a large number of cyclonic storms, many of which entered the continent below the mouth of the Columbia River. Heavy rains fell in California and elsewhere to the eastward, resulting in places in destructive floods. The world pressure distribution therefore is of especial interest. The pressure distribution of the immediately preceding month is described in the preceding paragraphs; the fact that anticyclones moved into the United States from the Pacific leads to the inference that high pressure prevailed over that ocean in December, 1915.

The outstanding feature of the departure chart for January, 1916, is an area of positive abnormality centered over Bering Sea and Alaska (17.3 mb. at Kodiak Island). Directly south of this area a tongue-shaped area of negative pressure departure with its maximum on the Oregon coast penetrates the Great Basin region; pressure was high over the Atlantic and the western Mediterranean, a reversal from the conditions of the previous month.

It seems reasonable to ascribe the movement of cyclones in low latitudes in the United States to the prevalence of high pressure in Alaska and the Northeast Pacific, and to the presence of low pressure areas over the Pacific in immediate contact with the high pressure in interior Alaska.

December, 1916 and 1917, respectively.—These two months are considered together because both were of the type showing exceptionally large positive departures in the polar basin and contiguous territory. In both months there was a center of great positive departure in Greenland and on the opposite side of the globe in northeastern Siberia with overflows to Labrador in both months, but in 1917 only to Alaska where a positive anomaly of 34.1 mb. (1 inch) was recorded. This month was preeminently the month of maximum positive pressure departure in the polar basin during the 8 years of record; it was also the fore-runner of the cold winter of 1917–18 in the United States.

Annual variations.—During the eight years there were two periods of rather widespread and intense negative and two of positive variations, respectively. The first negative variation began in the European Polar Basin and ended there. It endured from December, 1912, to April, 1913; the center varied in its position from month to month. The second great anomaly was that of October, 1913, to April, 1914, already described. The first extensive positive anomaly was that of December, 1916, and it was localized in the Polar Basin and adjacent areas of both continents; the second great positive anomaly occurred just 12 months later, viz, in December, 1917. Both were effective in producing cold weather in the United States, and the first-named was apparently the cause of a cold spring in 1917 west of the Rockies. The December, 1916, anomaly was associated with a very extensive negative anomaly that spread from the Canadian Maritime Provinces to the central Mediterranean. This fact doubtless made the spread of cold weather equatorward more easily accomplished than would otherwise have been the case. In the December, 1917, positive anomaly, the cold weather came to an end, in the United States at least, in February, 1918. The records for 1918 for places outside of North America are not yet available.

It is obvious that one of the first steps toward predicting an event is to discover when, where, and how the event occurs. I therefore now pass to a consideration of the influence exerted by the pressure abnormalities hereinbefore described and others not mentioned upon current weather in the United States.

EFFECT OF PRESSURE VARIATIONS ON TEMPERATURE

It rarely happens that monthly mean temperature in the United States for a period as long as a month is uniformly above or below normal in all parts of the area. If when it is everywhere above the normal we call the month 100 per cent warm and in like manner every month that is everywhere cold a month 100 per cent cold, and if we take into account only the eight years under consideration it is found that out of the 96 months only 8 of them could be considered as 100 per cent warm or cold. The warm months were March, 1910, November, 1913, January and October, 1914; the cold months were February, 1910, November, 1911, and December, 1917.

Examining the pressure departure charts for these and other months it is readily seen that the single dominating feature, in the case of warm months in the United States and Canada, is a rather pronounced depression of the barometer over northwestern Canada, interior Alaska, and by inference over the northeastern Pacific. A contributing cause in winter is a positive abnormality over the western Atlantic about north latitude 30° to 40°.

If warm weather is to be forecast for the United States and Canada we should be able to foresee that the path of cyclonic systems across the continent would be essentially along the 50th parallel of north latitude and that anticyclones for the most part would enter the continent from the Pacific rather than descend from the high latitudes of the interior of the continent. The two conditions just named are supplementary the one to the other. Low pressure over Alaska and the Canadian northwest is inimical to the development and maintenance of anticyclones, and experience shows that in those conditions anticyclones are given off from the North Pacific HIGH and therefore are not attended by severe cold.

The conditions for 100 per cent cold weather control are almost the exact reverse of those just described, viz, high pressure in Alaska and the Canadian northwest that extends southeastward to the eastern slope of the Rocky Mountains in Montana and Wyoming. In such a pressure distribution anticyclones advance in a southeastward path by way of the Missouri Valley to the neighborhood of Iowa, where they spread somewhat and move more in a true east direction. A contributing cause of low temperature in eastern sections of the United States is a pronounced depression of the barometer over the North Atlantic in the neighborhood of the Grand Banks. So much for the broader features of temperature and pressure relations.

A temperature distribution in the United States that frequently occurs is that best characterized by the expression "warm east, cold west of the Rockies." The mountains in these cases serve as a climatic divide between the above-normal temperature on one side and below normal on the other. Although the statistics are not at hand, I am of opinion that many of the anticyclones that move southeastward from Canada by way of the Missouri River Valley are shallow—that is, the extreme cold is confined to surface layers and there is not, therefore, an overflow of cold air toward the Pacific slope. Such overflow even in the absence of a mountain barrier would be greatly hindered by the prevailing eastward drift of the currents up to the cirrus level.

Cold weather in the Plateau and Great Basin [1] region seems to be due to the fact that in some seasons offshoots from the North Pacific HIGH impinge upon the California coast, drift north-northeast, and recurve to the southeast over the Great Basin region, where, due to the peculiar topography of that region and perhaps to a surface cover of snow they frequently lodge for days at a time. A snow cover and the intense outward radiation of that dry region must aid materially in prolonging the existence of anticyclones which come within its borders. These Great Basin anticyclones serve also to prevent cyclones from entering the continent over Oregon, northern California, and Washington, and thus their presence is inimical to rainfall in those States.

Another control of the temperature west of the Rockies is that exercised by high pressure over western Canada that apparently merges with the North Pacific High and forms a barrier over which offshoots from oceanic cyclones can not pass. (See Chart III, Tracks of Low Areas, April, 1917, MONTHLY WEATHER REVIEW.) When this happens many secondary cyclones develop over the southern Plateau and Rocky Mountain region and thus facilitate the indraught of cold northerly winds in their rear.

SEASONAL FORECASTING

The problem.—GIVEN, an atmosphere such as possessed by the earth which by reason of its movement through countless years has reached something akin to equilibrium in its moving parts, but which, however, is being constantly disturbed by both the local and the general circulations due to contrasts in temperature arising from greatly diversified cloudiness, the unequal heating of land and water surfaces, the change of seasons, and other causes:

REQUIRED.—To distinguish when and where the local and the general circulations will be most disturbed, the character of the disturbance, and finally, the effect of such disturbance on the weather a month or a season, hence.

The methods of the day-to-day forecaster who bases his predictions upon the predetermined geographic position of the significant barometric formations already in existence must be discarded as hopelessly impossible when an attempt is made to determine in advance the changes in geographic position, the growth and decay of cyclones and anticyclones already in existence, and the time and place of origin of new ones.

The seasonal forecaster must adapt himself to the formulation of a broadly generalized forecast, qualitative rather than quantitative. Is such a forecast for the changeable weather of temperate latitudes possible under present conditions? By present conditions I am referring to the lack of precise information as to current weather over large parts of the land areas and over practically all of the water surface of the globe.

The available printed meteorological records assembled for the globe as a whole cover but eight years, and for parts of Asia and Europe the continuity of the observations was broken by the World War. It is a question, moreover, whether the usual meteorological observations of pressure, temperature, moisture, wind direction, and speed and the face of the sky furnish in themselves sufficient data for the making of seasonal forecasts. Properly to answer this question would involve the critical examination of existing meteorological records of all time in a search for correlations between the weather in various parts of the globe. Sir Gilbert T. Walker, Director of the Meteorological Service of India, 1904–1924, has organized and prosecuted such a study and has given the results in a series of papers (*1*).

It is of particular significance in this connection that the only outstanding example of seasonal *weather* forecasting, or more specifically of seasonal *rain* forecasting, by an organized weather service is that of India. This service has regularly made since 1908 a forecast of the probable intensity of the monsoon rains of India several months in advance of the breaking of the monsoon.

Without detracting in the least from the efforts of Indian meteorologists to develop seasonal forecasts of rainfall on a scientific basis it should be remembered that there are several important factors in determining the rainfall of India that do not obtain elsewhere on the globe. Among these may be mentioned the following: (*a*) India is the only considerable land mass of the Northern Hemisphere that extends well into the Tropics, giving it therefore more stable weather conditions than prevail in the Temperate Zones; (*b*) the prevailing winds of the rainy season of India before passing over the land have traversed 4,000 miles of equatorial water, thereby absorbing both heat and moisture before impinging upon the land; and (*c*) the mountain systems of India are favorably disposed for augmenting the natural rainfall.

The four variables which enter into the formula used in forecasting the intensity of the monsoon rains of India are as follows: (*a*) Accumulation of snow in the Himalayas in May; (*b*) the current pressure at Mauritius; (*c*) South American pressure, March, April, and May; (*d*) the current rainfall in Zanzibar.

The monsoon breaks in June.—The data necessary to complete the formula become available late in May, so that the interval between the issue of the forecast about the first week in June and the coming of the rains is not a long one.

What most interests us in the formula above mentioned is the fact that pressure in far-off Argentina and Chile in March, April, and May varies in an opposite sense to that of India in June and July. The story of the discovery of this barometric seesaw, independently by the Lockyers and Bigelow in 1902, is an interesting one. Suffice it to say here that the English scientists endeavored to associate terrestrial pressure changes with the outbreak of solar prominences. In the course of the investigation it was shown that there were two great types of barometric variations, one varying directly with the prominences, the other inversely. Out of this study, which was not organized with reference to the problem of seasonal forecasting, came the important fact that pressure in South America in April and May varied inversely as that of India *two months later*, a discovery of much importance to Indian meteorologists.

Unfortunately a relations such as subsists between South American and Indian pressures is not known to exist between any other two regions, one of which must be in North America, in order to use pressure relations as a basis for seasonal forecasting for the United States.

Another case of barometric seesaw which might be of value in long-range forecasts, were it possible to predict the future pressure at one or the other of the two regions, is the relation which exists betweeen the pressure of two of the so-called "action centers."

Several European meteorologists, especially Meinardus (*2*) have shown the practical application of this relation to long-range forecasting.

[1] The term "Great Basin" as used in this paper refers to that portion of the western Cordilleran region which is characterized by wholly interior drainage, more especially the northern portion, or, roughly speaking, southeastern Oregon, southern Idaho, southwestern Wyoming, northern Utah, and northern Nevada. Representative Weather Bureau stations within this area are: Salt Lake City, Utah, Winnemucca, Nev., and Boise, Idaho.

In 1904 Hann pointed out that 80 per cent of the cases of great positive pressure anomalies at the Azores corresponded to negative anomalies at Iceland. I have examined the record of the pressure anomalies at the two places above mentioned for the years 1910–1917 and find that when only the anomalies of ±5mb. or greater are considered the statement by Hann is justified. Considering the months when the anomaly was ±3mb. or less it turns out that in 48 months of the 96 the variation was in the same sense in 20 cases and in an opposite sense in 28 cases. It was noticed, however, that at times of widespread variations from the normal, as in February, 1912, December, 1917, and other months, the variations were in the same sense rather than in an opposite sense. This would seem to indicate that both places respond in the same sense to great changes in the general circulation, excepting only that the magnitude of the response is conditioned by the latitude of the respective regions.

Hitherto in this discussion only contemporary pressure relations have been considered. If now we wish to learn whether a relation exists between the current pressure in one part of the globe and the pressure one, two, or three months later in some other part of the globe, recourse must be had to the statistical methods so ably practiced by Walker.

The correlation coefficient between Azores pressure, June to August, inclusive, with Iceland pressure for the same months, as computed by Walker, is −0.48, and the sign being minus indicates a reverse rather than a direct relation—that is to say, pressure at Iceland is low when it is high at Azores, and vice versa. The coefficient Azores pressure with that of Iceland one-quarter previous is, however, −0.06, an amount so small as to be without significance.

If we take Bermuda and St. Johns, a pair of meteorological stations on the western side of the north Atlantic, situated in some respects like the Azores and Iceland on the eastern side, and disregarding the magnitude of the variations, it is found that for the same eight-year period the variations were in an opposite sense in 54 per cent of the months and in the same sense in 46 per cent. Considering in the same manner the variations between Bermuda and the Azores, a variation in the same sense was found in 70 per cent and in the opposite sense in 30 per cent of the months, thus confirming the belief that pressure of the north Atlantic over the same general latitudes varies as a rule, as a single geographic unit.

The late Professor Garriott in 1908 announced (*3*) that—

> The character of the barometric distribution over the Pacific Ocean and the continent of Asia indicates the development or approach of storms and high pressure areas that will appear on the west coast of the [North] American Continent; and barometric conditions over the [North] Atlantic Ocean and Europe indicate the direction and speed of the movements over the North American Continent.
>
> Marked departures in the Asiatic area indicate the general character of the weather of the United States for a period of about two weeks in advance; and Pacific pressure conditions and changes furnish a key to weather changes that will occur on the Pacific coast of the United States 3 or 4 days in advance and indicate the character of those that will occur over the eastern portion of the United States 6 to 7 days in advance. * * *

At the time the above was written Garriott was making weekly forecasts for the United States and he continued to do so until his death in 1910. The revival of the weekly program by his successor on the Weather Bureau forecast staff Mr. E. H. Bowie in December 1913 is too recent to need discussion.

I have been interested, however, in a comparison between the pressure abnormalities of central Siberia and those of Alaska suggested by Garriott's studies. Using the 91 months for which the data appear in Reseau Mondial it was found that for contemporary pressures that Siberia varied in the same sense as Alaska in 45 months and in the opposite sense in 44 months, the variations in 2 months being indefinite; if, however, account is taken of only those variations that amounted to as much as ±3mb. in one or both regions the result is different, for example, variations of that amount occurred in 69 months or 76 per cent of the time. These variations were in the same sense in 49 per cent of the months and in an opposite sense in 28 per cent; they were indefinite in the remaining 23 per cent. Comparison was also made between central Siberian pressures and those of Alaska one month later, variations of ±3mb. only being considered. The result is given below:

Variations in the same sense	24 cases,	41 per cent
Variations in opposite sense	21 "	36 "
Variations indefinite	13 "	22 "

In the comparison it was noted, however, that at times the variations would be in an opposite sense for several months at a time and then the opposition would break down, so it is quite probable that forecasts based on an expected change in the pressure distribution in Alaska would be successful in a small per cent of cases. In the long run however there seems no ground for the belief that changes in pressure distribution in Siberia afford sufficient ground for forecasts for the United States, 10 days to 2 weeks in advance.

Walker (*4*) in discussing the correlation coefficients of central Siberian pressure with those of Alaskan and North Pacific pressure, says:

> In the winter table it is mainly with two quarters later that significant figures occur. High pressure in Central Siberia in winter is then followed by low pressure in San Francisco and high pressure in Alaska—i. e. by decreased oscillation in the North Pacific. * * *
>
> In summer central Siberia is fairly typical of the second group of the previous paper; i. e., low pressure there is associated with low pressure in Iceland, Alaska, and Northwestern India.
>
> * * * None of the coefficients individually is big enough to demonstrate reality, but the group of consistent relationships is too marked to be produced by accident.

Okada has worked out the relationships between pressure and temperature at Zikawei, a station on the Chinese coast at Shanghai, which he considers as representative of the Siberian HIGH. He finds that a rise in pressure is associated with a fall in temperature, the physical explanation being that a variation in the intensity of the Siberian HIGH during the winter causes corresponding variations in pressure at Zikawei and these bring cold northwesterly winds to that station. This relationship is of course one of contemporary conditions. Assuming that there is a lag between pressure variations in Siberia and weather in Japan some months later, Okada investigated the feasibility of forecasting temperature in Japan from Siberian pressure several months previous. He has published four notes on the results of this investigation (*5*).

The same author has since published two other papers "On the possibility of forecasting the summer temperature and the approximate yield of rice crop for northern Japan." (*6*).

The first paper deals with the facts established empirically that the August temperature in northern Japan, varies in harmony with that of the March pressure difference, Zikawei-Miyazaki and that of the South American pressure for March to May. In regard to these variations Doctor Okada remarks:

But, as in all efforts at the solution of seasonal forecasting there are some tantalizing exceptions in this harmony of the pressure and temperature variation. Hence we can not hope to establish a definite law of prediction or to calculate the approximate August temperature many months in advance. But the method described in this paper, though professedly imperfect will serve to show at least the sense of variation of the air temperature of the coming August and yield of rice crop in northern Japan at the beginning of June, when we have the telegraphic reports of the pressure data from Miyazaki in southern Japan, Zikawei in China, Santiago, and Buenos Ayres in South America.

In the second paper Doctor Okada first correlates mean temperature in winter at Nemuro, in northern Japan, with yield of rice crop in Hokkaido. He then correlates mean winter temperature at Dutch Harbor in the Aleutians with yield of rice in Hokkaido and deduces a coefficient of -0.631 (± 0.078) and from this he concludes

(1) Lower the mean temperature for January to March at Nemuro, in the previous year, lesser the yield of rice crop in Hokkaido than in previous year.

(2) Higher the mean temperature for January to March at Dutch Harbor than in previous year, lesser the yield of rice crop in Hokkaido than in previous year. Lower the winter temperature at Dutch Harbor greater the yield of rice crop in Hokkaido.

Mossman (*7*) also has made valuable contributions to the literature on seasonal weather correlations, his work being mostly confined to regions of the Southern Hemisphere.

It is due to Mossman that we have an account of a pronounced case of correlation that subsisted for a period of 17 years and then disappeared. The correlation was that between the rainfall of Trinidad (lat. 10° 40′ N.; long 61° 31′ W.) and of Azo, Argentina, (lat. 36° 31′ S.; long. 56° 46′ W.) and the period of years was 1878–1894. For these years a correlation coefficient of 0.79 (± 0.06) was found between the rainfall of Trinidad and Azo six months later, but when the entire record of 50-odd years is used the large correlation coefficient vanishes. Azo is in the south temperate zone and 2,850 geographical miles distant from Trinidad and Mossman naturally inquires whether the pronounced correlation as above was purely fortuitous or subject to cyclical repetition. Since weather changes in temperate latitudes drift from west to east we should expect to find more or less correlation between points along an east/west line. Such a correlation has been found between the temperatures at San Diego, Calif., and Jacksonville, Fla. (*8*).

Mr. Charles D. Reed in charge of the Des Moines, Iowa, U. S. Weather Bureau station has shown (*9*) that the mean June temperature of the State of Iowa is related in a definite way to the immediately following mean temperatures of July, August, and September, the correlation coefficient being $0.559 \pm .078$. The relation applies, however, only to a group of surrounding States and becomes less and less with distance from Iowa. A physical reason for the relation is not at once apparent; it does however, emphasize the importance of studying monthly sequences of the weather.

Seasonal forecasting from ocean temperatures.—The influence of the temperature of oceanic waters on the climate of adjacent land areas has long been known. With this knowledge as a starting point a number of investigators have endeavored to relate the temperature of the surface water in one or more of the best-defined currents of the North Atlantic, the Gulf stream and the Labrador current, for example, with the weather of northwestern Europe after an interval of several months. Pettersson, Meinardus, Hildebrandsson, and others have sought to find in the strength of the pressure gradient between the Azores and Iceland the key to the wind circulation of the intervening oceanic waters and have pointed out the probable results of increased wind circulation upon the distribution of ice in polar waters; since the increased flow of ice-bearing waters into the Gulf Stream might be expected to lower the temperature of that stream and this in turn would tend toward increased pressure in the neighborhood of Iceland, it is easily seen that the end result might have an important bearing upon the weather of northwestern Europe.

Exner (1913) made a systematic investigation by the method of correlation coefficients of the relations between the monthly deviations from normal of pressure and temperature for a number of stations in the Northern Hemisphere for the winter months, December–February.

The correlation coefficients between polar pressures and pressures in lower latitudes when plotted on a map show a region of high positive correlation around the pole, based mainly on high latitude stations of Europe and Asia, and a region of negative correlation over the Mediterranean, thus indicating a "see-saw" in the pressure relations of high and low latitudes, respectively. This result, however, refers to contemporaneous pressures and therefore has no special significance. The meteorological conditions in the north portion of the North Atlantic have been investigated to a greater extent, perhaps, than those of any other of the great oceans.

With respect to using the data of ocean temperatures in seasonal forecasting, Commander Hepworth, marine superintendent of the British Meteorological Office, sums up the situation in the following excerpt (*10*):

If, in connection with long-period forecasts of weather in these islands, sea surface temperature data be utilized at any future time, it will be necessary that a larger number of recent reliable observations be available weekly for all parts of the North Atlantic, than are available at present.

Without such a complete and continuous record it is impossible to interpret with accuracy the changes in the intricate distribution of sea surface temperature or to follow the movements of the respective water layers of Equatorial and Arctic origin * * *

Every one interested in the meteorology of the sea must know that the principal hydrographic services of the world do not publish or circulate current data of ocean surface temperatures and that to compile from their archives the current data of water temperatures for any one of the great oceans for a single month is a task totally beyond the ability of a single investigator. Hence we should take with a certain mental reservation the statements that occasionally appear in the public prints to the effect that ocean temperatures indicate thus and so for the coming years.

THE OUTLOOK FOR SEASONAL FORECASTING IN U. S.

As previously stated, the only seasonal weather forecasts now being made by an organized weather service are those of the Indian Meteorological Department. I have taken considerable pains to indicate the reasons why the method developed by that service is not of general application.

In the latest paper on the subject (*11*) there is a note of encouragement which I quote. After discussing the meteorological controls of the Pacific, Sir Gilbert remarks:

There are, however, grounds for satisfaction in the consistency of the relationships ascertained. Turning to the table in parargaph 57 above, if we examine the 150 significant coefficients between the 11 representative centers there enumerated, we shall find that the classification just given directly explains the sign of 149 of them. The solitary exception is the negative effect of Java rain (October to February) upon peninsula rain of the succeeding monsoon.

This consistency is very remarkable and supports the view that seasonal forecasting is capable of wider application than at present.

As hereinbefore indicated the pressure distribution that is associated with warm months and cold months in the United States and Canada is known, but as yet no promise is held out of our ability to forecast the pressure distribution of the North Pacific for a season in advance; moreover, the great accumulation of cold air in the polar basin of December, 1916, and December, 1917, appears to have been unattended by any thus far recognizable preliminaries, although in both cases exceptionally high pressure prevailed in various parts of the Northern Hemisphere, which apparently were consolidated in the polar basin in the months named. This is, however, merely an assumption that will have to be confirmed by many more years of observation.

The most important single variable involved is without question the variations in North Pacific pressures one quarter in advance and the influence of such variations upon the weather of North American Continent. A study of this variable would naturally require several collateral studies, for example, as to whether or not variations in the intensity of the Siberian HIGH of the cold season have a pronounced influence upon Pacific pressures to the east of Japan, and, if so, how far can they be traced? Another study might be concerned with the possible influence of early or late snowfall in the northern Canadian Rockies on the readiness with which oceanic cyclones pass inland during the cold season.

The foregoing suggestions are tentative and include those items which in the opinion of the writer would yield the most helpful results. Atlantic pressure is important, but must take a subordinate place to that of the Pacific. The hope of the future so far as seasonal forecasting for the United States is concerned lies in the Pacific.

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ON THE RELIABILITY OF HAIR HYGROMETERS

By L. T. SAMUELS

[U. S. Weather Bureau, Washington, D. C., December 9, 1925]

Humidity data recorded by the Weather Bureau are obtained chiefly from observations with psychrometers, supplemented at a few stations by records from hair hygrographs, the former, however, always being regarded as the standard. As is well known, the manipulation of the psychrometer at temperatures below freezing requires special care and considerably more time than at higher temperatures. With a view toward effecting an improvement in humidity determinations during low temperatures a hair hygrograph was exposed to various temperatures and humidities and its performance observed in relation to simultaneous readings of a whirling psychrometer exposed to the same conditions. The results obtained, preceded by a brief statement regarding the characteristics of both types of instruments, will now be presented.

The principal reason for the wide use of the psychrometer as compared with other types of hygrometers is the constancy of its indications, a truly valuable asset in any scientific instrument. However, it has frequently been used as a standard of reference under conditions where part of the so-called "error" of the compared instrument was the error of the psychrometer. Under the best conditions, i. e., when both thermometers are accurate, the wet bulb properly covered and moistened, the exposure and ventilation adequate, and the temperature *above* freezing, the humidity measurements from a psychrometer will be accurate within about 2 per cent, but if either the temperature or relative humidity is low, or the air approaching saturation, the errors may be larger than 10 per cent.[1] When the temperature is below freezing the errors of observation due to the smallness of the quantities to be measured are often exceedingly large, making other methods preferable at such times. For example, a depression of only 0.1° C. corresponds to a difference of 5 per cent in the relative humidity at −15° C., 7 per cent at −20° C., 18 per cent at −30° C., and 45 per cent at −39° C. Another source of uncertainty is the thickness of the ice covering the wet bulb, which, if more than a very thin film, appreciably retards the cooling of the bulb.

The most important defect in the hair hygrometer is the variability of its zero, a fact which is, however, often exaggerated in comparison with psychrometers, owing to the bad condition of the former as well as inaccuracies in the latter. In northern Europe and other regions where low temperatures are more or less common the hair hygrometer has been found very satisfactory, and wide experience has unquestionably shown that when properly cared for it is an excellent instrument. The technique of hygrometry is summarized in considerable detail in numerous publications.[2]

Mr. C. S. Ling, official in charge, of the aerological station at Drexel, Nebr., began early in 1924 a series of comparisons between a psychrometer and hair hygrograph. Owing to the fact that electric power for operating the ventilating fans could not always be obtained when desired at Drexel, these observations were trans-

[1] Shaw, A. Norman, Trans. Royal Soc. Canada. Vol. 10, 1916.

[2] "A Discussion on Hygrometry," by Shaw, Simpson, Griffiths, and others. Proc. Phys. Soc. of London, 1921–22, vol. 34; "Errors of Absorption Hygrometers." Annals Astron. Obs., Harvard Coll., Vol. LVIII, Pt. II, 1906, by S. P. Fergusson; and in less detail in the article on "Humidity" by Skinner in "A Dictionary of Applied Physics," vol. 3, Glazebrook and others, London, 1923, and by S. P. Fergusson, "Methods for measuring humidity," Jour. of the Optical Soc. of Amer. and Rev. of Scient. Inst., vol. 10, No. 1, January, 1925.

ferred to the aerological station at Ellendale, N. Dak., during the summer of 1924, where they were continued until the spring of 1925. A hygrograph, one of the pattern in general use in the bureau, was furnished Ellendale after having been put in proper working condition at the central office. The procedure followed is described by Mr. L. A. Warren, official in charge, as follows:

> After the hygrograph was properly adjusted it was placed in the thermometer shelter and allowed to run continuously for two months in the early autumn, when air temperatures were favorable for comparisons with the psychrometer. The record sheets were changed weekly and artificial ventilation provided when necessary by means of an electric fan placed in the shelter. Comparative observations were made bihourly every day until 4 p. m. and occasionally during the evening. Following this, the hygrograph was fitted with a 29-hour clock drum and placed in the testing box used for standardizing meteorographs, where it was compared with a psychrometer at various humidities and temperatures. Efforts to secure low humidities simultaneously with low temperatures were unsuccessful, since the boxes are not equipped with devices for controlling the latter. Later, however, a fairly large number of comparisons were obtained in the open air at temperatures between 0° C. and −20° C. The following procedure was employed: A shelf was built outside the office window whereon the instrument could be exposed either inside or outside the testing box, as might be desired, in the blast of an electric fan operated from inside the office. Exposed in this way the instruments could be read through the closed window and any effect of the observer's body or of air from the room entirely eliminated.
>
> Throughout these comparisons special precautions were invariably taken to provide sufficient ventilation and to prevent, so far as possible, any artificial effects from reaching the instrument; also to secure an accurate record by the hygrograph by maintaining the lightest possible pressure of the pen and carefully jarring it before making readings.

Considering the psychrometer as the standard it was found that out of a total of 501 comparisons made at various humidities with temperatures ranging from −16.2° C. to 38.8° C., 93.7 per cent of the differences were within ±5 per cent (relative humidity), while none was larger than ±8 per cent. It is evident from Figure 1, showing the distribution of these differences, that they are fairly symmetrical and that a larger number of comparisons would undoubtedly make them more nearly so. The standard deviation of the differences for all temperatures used was 3.04 and the probable error 2.05. These values were not materially reduced when based on only those readings made at temperatures above freezing, indicating thereby no appreciable effect on the hairs due to the low temperatures. It may therefore be assumed that if an instrument of this type functions satisfactorily for an extended period at ordinary temperatures above freezing it will continue to do so at temperatures below freezing.

The excellent performance here indicated is all the more convincing when it is understood that throughout the entire series of comparisons at Ellendale (August, 1924, to March, 1925) the pen of the hygrograph was never reset. It is evident, therefore, that the hair hygrograph when properly exposed and cared for is a very dependable instrument, and it would seem advisable in making humidity observations, especially during low temperatures, to be guided to some extent by the indications of this instrument. These conclusions apply to "indicating" as well as to "recording" hair hygrometers (hygrographs) and confirm the experience of European observers previously referred to.

At the aerological stations of the Weather Bureau provision against sudden failure of the hygrograph is made by employing a dial-reading hair hygrometer in conjunction with the former and the psychrometer. At low temperatures when the psychrometer is believed to be appreciably in error the indications of the hygrometer and hygrograph are observed and if in close agreement with each other they are assumed to be correct; whereas, if pronounced differences occur, the source of error is ascertained by comparisons with a psychrometer at temperatures above freezing, secured indoors if necessary.

In caring for a hygrograph the most important feature is that of keeping the hairs clean and absolutely free from grease and oil. For this reason they should not be touched with the bare fingers. Dust can usually be removed from the hairs with a camel's-hair brush, which may be used either dry or dipped in clean distilled water or pure grain alcohol, depending on the condition of the hairs. If they have become oily or greasy, it may be necessary to resensitize them by allowing them to soak for a short time in ether. Too frequent sensitizing, however, causes them to become brittle. The mechanism, clock, etc., are of course susceptible to all influences that affect thermographs and other similar instruments and should be cared for accordingly.

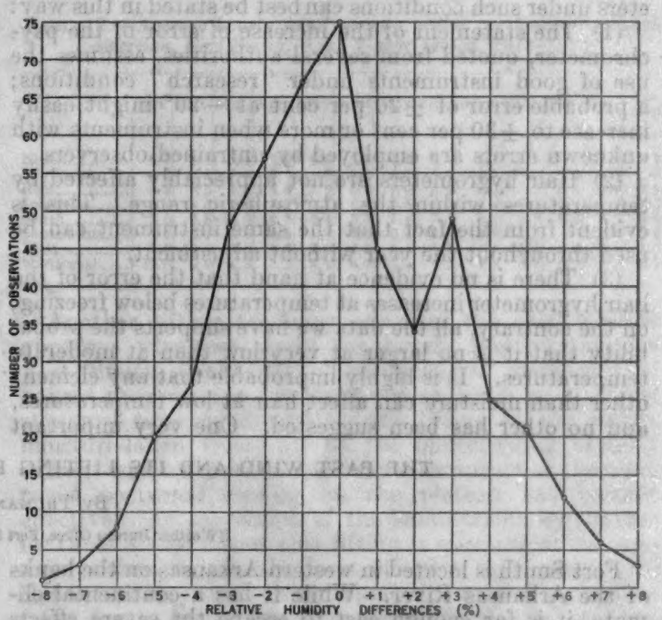


FIG. 1.—Frequency of the various differences between readings of hygrograph and psychrometer at temperatures ranging from −16.2° C. to 38.8° C. (Psychrometer regarded as the standard.)

DISCUSSION

Mr. Samuels' comparison supplies information that was lacking in 1921, when the measurement of humidity at northwestern stations was under consideration. At that time the inadequacy of the psychrometer at low temperatures was admitted, but the substitution therefor of the hair hygrometer was deemed inadvisable until the behavior of the latter instrument at temperatures below freezing was better understood. The new data sustain the conclusions of Wild, Rykatchew, and other authorities familiar with the performance of hygrometers in cold climates—that the hair hygrometer is superior to the psychrometer at low temperatures—in that the differences between the two are no larger than should be expected from the rate of increase of the error of the latter, which is known to be very rapid as the temperature falls below freezing.

The hair hygrometer should be standardized at temperatures down to −40° or lower, by comparison with the chemical hygrometer or other apparatus the errors of which should not exceed 10 per cent. Doctor Sverdrup's modified aspiration psychrometer, in which are employed thermopiles reading to 0.001° C., promises to be useful, since it is free from instrumental errors unavoidable when thermometers are used, but the usual precautions regarding management and exposure, etc., will be necessary. The standardization of several instruments should be sufficient to determine the probable errors of hair hygrometers as a class, and thereafter changes of zero or range can be detected by comparisons at temperatures above freezing.

It should be stated, however, that although the extension of this work is most desirable, accumulated experience and the data already at hand indicate clearly that at the present time records of humidity in cold climates could be improved very decidedly by the use of the hair hygrometer when the temperature is low. The relative merits of psychrometers and hair hygrometers under such conditions can best be stated in this way:

(1) The statement of the increase of error of the psychrometer, quoted from several authorities, assumes the use of good instruments under "research" conditions; a probable error of ±20 per cent at −20° might easily increase to ±30 per cent or more when instruments with unknown errors are employed by untrained observers.

(2) Hair hygrometers are not appreciably affected by temperatures within the atmospheric range. This is evident from the fact that the same instrument can be used throughout the year without adjustment.

(3) There is no evidence at hand that the error of the hair hygrometer increases at temperatures below freezing; on the contrary, all the data we have supports the probability that it is no larger at very low than at moderate temperatures. It is highly improbable that any element other than moisture can affect hair at low temperatures, and no other has been suggested. One very important advantage possessed by the hair hygrometer—obvious to all—is that, since readings can be made "at sight" before the surrounding air is influenced by the observer's body, the data are not subject to the errors of condition so difficult to avoid when the psychrometer is employed.

Consequently when one of two methods fails (as we know the psychrometer does) and the error of the other is not known to increase at low temperatures, we can not do better than to use the one that will come nearest to yielding the data desired. Even if the data are to an indefinite extent qualitative, the direction of a change of condition is often of more importance than its extent.

As suggested for the aerological stations, two instruments, the hygrograph and a simple, nonrecording instrument (preferably of the single-hair type), could be kept in use at all northern stations and the mean of their readings adopted as the relative humidity at any observation. Under ordinary circumstances, the change of zero (the only serious defect of the hair hygrometers) can be found and corrected by means of comparisons with the psychrometer when the temperature is above freezing, taking care to ventilate both instruments and protect them against artificial heating, etc. Changes of range, obviously, can be detected by the same method when the range of humidity within a short period of time is large; but a more satisfactory method, particularly in winter, when the humidity in heated rooms is low, is that of comparing the instruments at the conditions prevailing in the room and afterwards determining the errors of the hair hygrometers near saturation by covering them with a saturated bath towel. The highest humidity ordinarily attainable by this method in a dry room is about 96 or 97 per cent; but, while we may agree with Napier Shaw in our dislike for a method that does not quite give us the saturation point, we know from experience that a hair hygrometer adjusted to read 96 per cent under a moist cloth will read 100 per cent when the air itself is saturated—and the method is so simple that it can be used by anyone.—*S. P. Fergusson.*

THE EAST WIND AND ITS LIFTING EFFECTS AT FORT SMITH, ARKANSAS

By TRUMAN G. SHIPMAN

[Weather Bureau Office, Fort Smith, Ark., December 16, 1925]

Fort Smith is located in western Arkansas on the banks of the Arkansas River. While it has a continental climate, it is far enough east to escape the severe effects of the "norther" of the western plains and is near enough to the Gulf of Mexico to have its winter temperature moderated by southerly winds. The surrounding topography is the cause of several local features of climate. It is my purpose to discuss them because they have a bearing on local forecasts.

The Arkansas River at Fort Smith flows through a valley which is many miles wide in eastern Oklahoma, but narrows to almost a point 100 miles east of Fort Smith. North of the valley are the Boston Mountains, which extend from northeastern Oklahoma about two-thirds across Arkansas, and reach elevations of about 2,300 feet in Newton County, Ark. The Ozark Plateau, about 40,000 square miles in extent, lies northeast of the valley. South of the valley, a range of hills and mountains, beginning with the Arbuckle and Ouachita Mountains in southeastern Oklahoma, extends eastward to central Arkansas. Peaks in this ridge reach elevations of 2,500 to 3,000 feet, although the average height is less. Thus it is seen that Fort Smith is near the center of the wide end of a V-shaped lowland.

The most striking feature of climate at Fort Smith is the prevailing east wind, which blows 41 per cent of the time. This occurs in a region where north to northwest winds are expected in the winter season and southerly in the summer. The wind is mainly a plateau-valley breeze, although the seasonal low pressure area over the center of the continent in summer is a contributing factor in increasing the percentage at that season. The wind originates on the Ozark Plateau to the northeast; as a result of the more rapid nocturnal cooling there than that which takes place at the lower elevations. It flows thence down the southern slope of the Ozarks and, as it reaches the valley floor, its direction is determined by the trend of the valley. Since the eastern end of the valley has only a narrow outlet, the air flows towards the wider opening in the west, thereby becoming an east wind.

It is the opinion of the writer that this wind is rather shallow, perhaps not more than 1,500 to 2,000 feet in depth; that its depth is the elevation of the plateau above the valley and tapers to nothing about 50 miles west of Fort Smith. The conditions above Fort Smith [1]

[1] U. S. W. B., Bull. F, Report of Kite Observations, 1898, p. 29.

vary from those observed at other stations made during the same year where kite observations were made. The differing conditions appeared at elevations from 1,500 to 2,000 feet and support the above opinion. To quote the bulletin, "The mean decrease in temperature with increase of altitude was 6.1 degrees for each 1,000 feet. The gradient decreased slowly up to 2,000 feet and quite rapidly thereafter, a departure from the conditions prevailing elsewhere." However, kite observations were made in the daytime and differences are undoubtedly more pronounced at night. Quoting Bulletin F further, "The observations were equally divided between the mornings and afternoons, and the means were exactly equal. The gradients also differed but little up to the different altitudes, except at 1,000 feet, where the morning one was 2.6 degrees larger." Also, "The clear and cloudy weather gradients were exactly alike up to 2,000 feet; up to 1,500 feet, the cloudy was 1.2 degrees larger than the clear one, while up to the remaining altitudes, the clear weather ones were the greater."

Fort Smith lies in a region of considerable atmospheric instability. Thunderstorms occur here when they appear at no other place on the weather map. False cirri are sometimes observed near the base of the overflowing current. Occasionally cumulus or cumulo-nimbus bases are observed moving in a different direction from which the summits are moving.

A tabulation to determine the exact percentage of nighttime east winds and daytime east winds has not been made, nevertheless, an inspection of the prevailing hourly directions recorded in the Climatological Record, and of several individual monthly records of prevailing hourly wind direction, supports the conclusion that the percentage of east winds at night averages over 50 most of the year. Since the east wind is cool, it flows close to the surface of the earth. Thus while it prevails it lifts other winds which are passing over the valley. This lifting tendency has an important bearing on forecasts for precipitation and temperature made for Fort Smith and adjacent territory.

It is a cause of delayed temperature effects at Fort Smith, as well as of the reduced number of cold waves. Frequently during the first day of a cold wave in the surrounding country, the cold is still 1,000 to 2,000 feet above Fort Smith unless the westerly wind is strong enough to displace the easterly. The coldest weather in sudden drops of temperature at Fort Smith usually comes on the second morning, or at the time the center of the cold area lies northeast of Fort Smith, in such a position that the anticyclonic outflow coincides with the predominating easterly wind, which then carries the cold into the valley. Northwest Arkansas had 31 cold waves in 10 years [1] while Fort Smith had but 19. Temperatures in cold waves are several degrees colder a short distance west of Fort Smith in Oklahoma because the lifting effects of the easterly wind is not operative there.

The overcoming influence of westerly winds is apparent in the increase of percentages of winds from westerly directions as the average velocities for these directions increase. (See Tables 1 and 2.)

TABLE 1.—*Average percentage of hours of wind movement from each direction, Fort Smith, Ark., 7-year period, 1918–1924*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
North	8.1	11.6	10.0	5.9	7.6	5.4	7.4	5.1	10.1	8.1	9.1	7.0	8.0
Northeast	6.0	5.0	4.6	5.6	7.1	6.8	8.0	6.7	10.3	8.7	6.7	5.1	6.7
East	42.7	33.0	38.4	39.0	38.9	40.6	41.7	46.4	45.0	50.6	38.4	38.9	41.1
Southeast	2.9	3.1	6.6	7.3	10.3	10.9	7.8	7.2	9.1	6.3	3.7	1.9	6.4
South	4.6	6.3	11.6	11.7	11.7	15.0	11.5	12.7	10.1	6.4	5.8	5.0	9.4
Southwest	13.4	14.9	9.1	11.3	10.1	11.6	12.6	14.4	7.8	7.4	15.5	17.9	12.1
West	8.9	10.6	6.9	9.1	5.6	4.6	5.4	3.8	2.9	4.8	9.0	8.9	6.7
Northwest	13.4	15.4	12.9	10.1	8.4	4.9	5.1	3.5	4.9	8.0	11.6	15.1	9.4

TABLE 2.—*Average hourly wind velocity, miles per hour, from each direction, Fort Smith, Ark., 7-year period, 1918–1924*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
North	6.7	8.4	8.1	6.9	6.4	5.6	5.5	6.1	6.6	6.4	6.9	8.8	6.9
Northeast	4.7	5.4	5.6	5.5	4.6	4.2	4.1	4.4	4.3	4.1	4.2	5.3	4.7
East	8.9	9.5	9.1	9.6	7.9	6.5	6.0	6.4	6.5	7.3	8.0	8.9	7.9
Southeast	6.3	8.0	9.7	9.7	7.7	6.1	5.8	6.2	6.8	7.8	7.2	8.8	7.3
South	8.0	9.8	10.8	10.5	9.4	8.1	7.4	7.3	8.3	9.8	9.4	9.3	9.0
Southwest	7.2	8.7	10.8	10.5	7.3	7.9	6.4	6.8	6.9	7.7	7.0	8.4	8.0
West	9.9	11.6	12.9	12.6	7.8	6.3	5.4	5.2	5.6	6.9	9.0	10.1	8.6
Northwest	10.0	9.8	11.5	11.2	9.4	6.3	5.7	6.1	6.8	7.7	9.2	10.3	8.7

Another lifting tendency effect of the east wind is apparent when we study the hourly precipitation for Fort Smith (Table 3). The principal maximum of hourly precipitation for the year, at 10:00 p. m., local standard time, is caused by the lifting of the warm, moisture-laden valley air by the underflowing easterly current which has started as soon after sunset as the more rapid nocturnal cooling on the plateau has become effective. An inspection of the summations by seasons in Table 3 shows that this lifting is effective at all seasons; although it is the least effective in summer. In this season daytime convectional rains exceed in amount rains due to lifting; and, furthermore, the atmospheric moisture is probably reduced by convection to such a point that the lifting influence is not effective in producing precipitation when the valley breeze begins.

[1] W. B. No. 533, Weather Forecasting in the United States, p. 148.

TABLE 3.—*Hourly occurrences and hourly totals of precipitation, Fort Smith, Ark., 1904–1923, inclusive*

	A. M.												P. M.											
	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid-night
December																								
Occurrences	47	49	52	50	57	57	70	80	83	78	79	84	83	70	74	75	69	69	68	66	69	67	60	50
Hourly totals	2.08	2.22	2.16	2.50	2.08	1.76	1.45	1.69	2.49	2.07	2.02	1.41	1.60	1.88	1.41	1.75	2.55	1.85	1.21	1.38	2.47	2.34	1.81	1.23
January																								
Occurrences	42	46	43	48	61	65	80	86	86	80	75	76	78	76	68	68	67	71	70	82	77	80	67	52
Hourly totals	2.49	1.65	1.56	1.81	2.25	2.02	2.52	2.59	2.80	2.10	2.11	1.73	2.08	2.19	2.22	2.46	2.49	1.79	1.90	1.60	2.00	2.43	2.10	3.09
February																								
Occurrences	44	46	47	44	47	45	56	65	69	71	63	58	51	56	61	55	65	64	72	67	64	62	54	53
Hourly totals	1.82	1.08	1.46	1.81	1.24	1.40	1.28	1.95	1.97	1.58	1.07	1.38	1.34	1.28	0.81	1.31	2.44	2.27	2.21	1.66	2.13	2.55	2.10	2.45
WINTER TOTALS																								
Occurrences	133	141	142	142	155	167	206	231	238	229	217	218	212	202	203	198	201	204	210	215	210	209	181	155
Hourly totals	6.39	4.95	5.18	6.12	5.57	5.18	5.25	6.23	7.26	5.75	5.20	4.52	5.02	5.35	4.44	5.52	7.48	5.91	5.32	4.64	6.60	7.32	6.01	6.77
March																								
Occurrences	51	46	51	51	53	59	68	78	70	56	57	62	64	62	60	56	60	61	64	71	68	67	61	61
Hourly totals	2.82	2.25	1.97	1.89	1.78	1.82	2.26	1.61	1.73	2.11	1.85	1.43	1.77	2.13	2.15	2.04	2.38	2.96	1.82	1.93	2.16	2.73	2.84	2.57
April																								
Occurrences	45	51	52	53	57	60	80	80	71	66	71	69	74	72	67	70	67	59	66	63	65	70	59	48
Hourly totals	3.19	2.81	2.89	2.13	3.21	3.31	3.14	2.96	3.06	2.29	3.04	3.15	2.51	2.84	2.68	4.35	3.36	3.44	2.05	2.32	2.05	4.51	3.48	2.50
May																								
Occurrences	53	57	55	61	60	58	70	70	58	55	59	63	65	56	60	56	71	60	58	70	62	67	65	51
Hourly totals	3.69	3.18	4.67	4.52	2.96	3.15	3.40	2.22	2.61	2.24	4.48	3.49	2.98	3.38	3.45	3.82	5.14	3.49	4.24	2.83	3.49	5.71	6.21	4.70
SPRING TOTALS																								
Occurrences	149	154	158	165	170	177	218	228	199	177	187	194	203	190	187	152	198	180	188	204	195	204	185	160
Hourly totals	9.60	8.24	9.53	8.54	7.95	8.28	8.80	6.81	7.40	6.64	9.37	8.07	7.26	8.35	8.28	11.11	10.88	9.89	8.01	7.08	7.70	12.95	12.53	9.77
June																								
Occurrences	26	30	34	35	32	42	50	52	52	47	46	50	58	54	40	39	52	52	56	58	44	30	25	20
Hourly totals	4.21	1.96	2.76	3.64	4.50	2.80	3.33	2.53	3.21	4.61	2.76	2.91	4.67	2.84	3.64	1.98	2.56	2.55	3.91	2.26	1.26	0.83	1.48	0.99
July																								
Occurrences	24	20	24	33	31	30	34	41	44	39	38	36	36	38	40	52	52	49	32	38	34	27	19	21
Hourly totals	1.29	3.53	2.30	2.12	1.94	2.48	2.85	3.87	2.67	2.24	2.51	1.89	1.09	2.39	4.25	3.29	3.08	4.42	1.96	2.25	2.69	2.18	1.48	1.31
August																								
Occurrences	21	20	28	34	35	51	61	56	48	44	43	45	47	30	48	55	47	52	48	43	36	27	21	21
Hourly totals	3.00	1.71	2.01	3.25	4.14	4.06	3.44	3.02	3.15	2.97	1.94	1.44	1.85	1.51	3.43	5.30	3.23	1.51	1.46	1.67	1.33	3.48	1.48	3.87
SUMMER TOTALS																								
Occurrences	71	70	86	102	98	123	145	149	144	130	127	131	141	131	128	146	151	153	136	139	114	84	65	62
Hourly totals	8.50	7.20	7.67	9.01	10.58	9.34	9.62	10.02	9.03	9.82	7.21	6.24	7.61	6.74	11.32	10.57	8.87	8.48	7.33	6.18	5.28	6.49	4.44	6.17
September																								
Occurrences	22	26	26	33	39	42	54	56	52	52	56	46	47	47	48	46	36	40	30	26	31	39	39	25
Hourly totals	1.55	0.58	1.73	2.67	2.97	2.58	2.13	1.50	2.11	3.25	2.97	2.14	1.91	1.71	2.93	1.27	2.55	1.68	1.95	1.40	1.56	4.08	2.80	1.40
October																								
Occurrences	33	35	41	41	44	51	51	53	44	48	48	46	52	46	46	50	45	39	48	52	48	45	44	41
Hourly totals	0.99	2.84	2.90	2.11	3.54	2.46	3.24	2.28	1.62	2.31	2.44	1.96	1.82	1.13	2.40	2.34	2.84	3.26	1.86	1.73	2.22	2.29	1.90	1.56
November																								
Occurrences	38	43	42	46	46	56	61	58	69	62	63	54	52	48	51	46	43	41	48	55	46	44	46	40
Hourly totals	2.89	2.25	2.54	2.41	1.91	1.94	1.24	1.30	1.47	2.18	1.68	2.36	2.55	2.70	2.14	2.36	1.29	1.42	1.75	1.31	2.29	2.32	2.06	2.04
AUTUMN TOTALS																								
Occurrences	93	104	109	120	129	149	166	167	165	158	167	146	151	141	145	142	124	120	126	133	125	128	129	106
Hourly totals	5.43	5.67	7.15	7.19	8.42	6.98	6.61	5.03	5.20	7.74	7.09	6.46	6.28	5.54	7.47	5.97	6.68	6.36	5.56	4.44	6.07	8.69	6.76	5.00
ANNUAL TOTALS																								
Occurrences	446	469	495	529	552	616	735	775	746	694	698	689	707	664	663	668	674	657	660	691	644	625	560	483
Hourly totals	29.92	26.06	29.53	30.86	32.52	29.78	30.28	28.09	28.89	29.95	28.87	25.29	26.17	25.98	31.51	33.17	33.91	30.64	26.22	22.34	25.63	35.45	29.74	27.71

There are for the year as a whole, three maxima of hourly precipitation at Fort Smith; the principal one at 10 p. m. has been discussed above. The one at 5 p. m. is due to rain caused by convection and the effects are more pronounced in the values for spring and summer. Since lowering the temperature of a volume of air reduces its capacity for moisture, increases its relative humidity, and, if carried far enough will produce condensation and precipitation, an increase in the hourly amounts of precipitation would be expected at the time of the daily minimum temperature, due to nocturnal cooling. Such a maximum appears in the tables under discussion at 5 a. m. However it is the least of the maxima.

The three causes of precipitation discussed are not often operative on the same day at Fort Smith. Any one of them operating any length of time is likely to deprive the air of available moisture. When one has operated, or is operating, it is unlikely that the others will become effective soon with any degree of frequency. In summer, when thunderstorms occur and convection has taken place

late in the afternoon, it is most unlikely that any precipitation will occur at night as a result of the lifting tendency, since the atmospheric moisture has been greatly reduced. This is evidenced by the high 3 p. m. totals on the sums for June, July, and August, the season when thunderstorms are most frequent and the lower totals at 10 p. m. when the lifting process should be active. On the other hand, if the time for the convective rains passes, without precipitation and the air is moisture laden, the lifting tendency is almost certain to produce precipitation as soon as the cool air sinks to the valley and lifts the moist air.

The totals for autumn, winter, and spring show slightly increased values at 10 p. m., when the lifting process is active, over the values late in the afternoon when convection is predominant.

The minimum at 12 noon is the result of increased capacity of air for moisture caused by diurnal warming, and occurs before convection begins to produce precipitation. The primary minimum in the tables for the year at 8 p. m. represents a lull between the average time of greatest convection and the average time of greatest lifting effect in producing precipitation. It can not be attributed directly to any physical process, but rather to the absence of any physical causes of precipitation. That this minimum should occur between the primary and secondary maxima is striking, especially when the maxima are only five hours apart. The rapid rises to both maxima and the rapid returns to both minima are indicative of the sudden effectiveness of convection and of the lifting effect in causing precipitation and of relieving the air of available moisture. An inspection of curves drawn from values in the tables leads to the conclusion that it requires about two hours for the lifting process to become effective here.

An added proof that lifting of warm air as described above is an important physical process in producing precipitation is found in the monthly and annual totals of precipitation at cooperative stations located on the southern edge of the Ozark Plateau.[3] These stations show increased values at points where this process is first operative.

The hourly occurrences of precipitation (Table 3), regardless of amount, show a maximum at 8 a. m. and a minimum at 1 a. m. The lack of eye observations at night may play a small part in causing the minimum at night, but that is not the only cause. The season with the largest number of hours with precipitation, winter, is also the season with the least amount of precipitation as shown by the hourly totals. It proves that the processes at work during the warm season are more effective in producing rainfall than the processes active during the cold season are.

[3] Climatological Data for United States by sections, secs. 47 and 48, 1917 Ed.

THE WEATHER OF 1925 IN THE UNITED STATES

By ALFRED J. HENRY

Temperature.—As a whole, the year must be classed as a warm one, thus completing a series of five consecutive warm years beginning with 1921. February, March, and April, 1925, were warm, from 3 to 5 degrees above the average; no abnormally cool weather occurred until October, that month being unusually cool in the Missouri and upper Mississippi Valleys and in parts of the Plains States. October was also characterized by the occurrence of rather early and heavy snow in the northern Rocky Mountain region. December was warm until the close of the month, when a cold spell reached the Gulf region.

The geographic distribution of the temperature abnormality is shown in Figure 1, and the monthly departure from the normal for geographic districts is presented in Table 1.

TABLE 1.—*Temperature departures, 1925*

District	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average monthly departure
New England	−2.7	+7.5	+5.7	+1.9	−1.6	+2.9	−1.1	+0.3	−0.3	−5.7	+0.4	+0.2	+0.6
Middle Atlantic	−0.9	+7.2	+4.1	+2.7	−3.0	+4.4	−0.3	−0.9	+3.3	−3.5	−0.9	−0.1	+0.8
South Atlantic	+0.6	+5.2	+2.8	+2.9	−2.3	+2.5	+1.8	+0.6	+7.0	−0.4	−1.9	−1.4	+1.4
Florida peninsula	+5.4	+1.2	+0.1	−0.3	−1.4	+0.2	+0.4	+0.4	+1.4	+2.3	+0.4	+0.1	+0.8
East Gulf	+1.6	+3.9	+2.3	+4.3	−1.3	+2.2	+0.9	+1.1	+7.9	+0.1	−1.4	−2.5	+1.6
West Gulf	−1.1	+5.9	+3.8	+5.0	0.0	+3.3	+1.6	+1.0	+4.0	−2.6	−0.5	−4.0	+1.4
Ohio Valley and Tennessee	+0.7	+6.3	+3.1	+4.9	−4.2	+3.7	−0.2	+0.8	+7.2	−6.3	−1.4	−2.9	+1.0
Lower Lakes	−2.9	+6.7	+4.4	+3.0	−4.8	+2.7	−2.1	+0.5	+1.8	−8.3	−0.8	−1.7	−0.1
Upper Lakes	−0.6	+4.0	+3.0	+4.5	−3.2	+1.8	−1.3	+2.3	+2.1	−8.7	−1.1	−2.6	0.0
North Dakota	+5.0	+8.7	+6.3	+8.0	0.0	−0.9	−1.3	+2.7	+1.0	−9.6	+2.5	+4.3	+2.2
Upper Mississippi Valley	+1.4	+6.1	+4.8	+6.8	−3.2	+1.7	−0.6	+1.1	+5.3	−10.2	−1.0	−3.7	+0.7
Missouri Valley	0.0	+7.4	+6.1	+7.6	−1.4	+2.1	+0.5	+2.1	+4.6	−10.4	+1.0	−0.3	+1.6
Northern slope	+3.3	+10.1	+4.5	+4.4	+2.1	+0.6	+2.0	+0.1	0.0	−8.8	+1.2	+4.5	+2.0
Middle slope	−2.1	+7.5	+5.7	+5.8	+1.0	+4.4	+1.5	−0.1	+2.4	−8.4	+0.2	+0.4	+1.5
Southern slope	−1.9	+6.6	+5.0	+5.1	0.0	+2.5	+1.4	−1.2	+0.2	−4.3	−0.4	−2.8	+0.8
Southern plateau	−1.1	+3.6	+3.3	+3.0	+3.6	+0.5	+1.5	−1.4	−0.4	−0.7	−1.1	−1.1	+0.8
Middle plateau	−1.2	+5.4	+2.0	+2.2	+5.1	−0.2	+3.0	−2.1	−1.8	−0.7	−0.6	+3.0	+1.2
Northern plateau	+4.7	+8.3	+2.2	+3.0	+3.9	+2.1	+5.1	0.0	+0.5	−1.0	−0.3	+4.1	+2.7
North Pacific coast region	+3.1	+3.9	+0.6	+1.8	+3.3	+0.9	+1.7	−0.1	+1.2	+0.7	+0.8	+3.4	+1.8
Middle Pacific coast region	+0.8	+2.7	+0.7	+0.8	+1.0	+1.5	+1.6	−0.6	−0.9	+0.5	−0.3	+1.3	+0.8
South Pacific coast region	+1.8	+2.6	+0.9	+0.5	+1.4	+0.9	+2.2	−1.0	−1.2	−0.4	+0.8	+3.9	+1.0
United States	+0.7	+5.8	+3.4	+3.7	−0.2	+1.8	+0.9	+0.3	+2.2	−4.2	−0.2	+0.1	+1.2

Precipitation.—Precipitation was deficient in the great majority of districts; it was most pronounced in the north Pacific States, the Atlantic States south of Virginia, also in the Gulf region. There was more than the normal precipitation in the region stretching from southern Utah and southern Nevada northeastward to the Canadian border. Smaller areas of more than the average rainfall may be found in various parts of the country—Figure 2 and Table 2.

TABLE 2.—*Precipitation departures, 1925*

District	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Accumulated departure for the year
New England	−0.2	−1.1	+0.1	−1.1	−1.1	+0.3	+0.4	−2.0	−0.2	+0.8	−0.4	−0.6	−5.1
Middle Atlantic	+1.0	−1.7	−1.3	−0.6	−1.5	−1.1	+1.1	−2.2	−1.3	+0.6	−0.2	−0.9	−8.1
South Atlantic	+2.8	−1.9	−2.4	−1.2	−1.1	−1.7	−3.2	−3.0	−2.6	−0.7	−0.2	+0.2	−15.0
Florida peninsula	+1.4	−0.8	−0.9	+0.4	+5.8	−2.0	0.0	+1.9	−3.9	−3.4	+6.0	+0.6	+5.1
East Gulf	+3.6	−2.1	−3.4	−2.7	−0.5	−1.6	+0.9	−3.3	−2.0	+3.0	+1.3	−0.8	−7.6
West Gulf	−1.1	−1.7	−2.2	−1.8	−1.9	−1.1	−0.9	−1.6	+1.3	+3.8	+1.0	−1.3	−7.5
Ohio Valley and Tennessee	−1.4	−0.9	−1.9	−1.4	−1.6	−1.2	−0.1	−1.6	+0.4	+3.8	+0.9	−2.2	−7.2
Lower Lakes	−0.5	+0.2	+0.4	−0.5	−1.5	−0.7	+0.6	−1.2	+2.3	+0.7	+0.3	−0.9	−0.8
Upper Lakes	−1.2	−0.4	−1.0	−0.7	−2.2	−0.7	−0.1	−1.1	+0.5	−0.1	−0.7	−0.6	−8.3
North Dakota	−0.4	−0.1	−0.2	−0.3	−0.8	+1.6	−1.1	−1.4	+1.8	−0.4	−0.3	−0.2	−1.8
Upper Mississippi Valley	−1.3	−0.3	−1.1	−0.9	−2.8	+1.6	+0.1	−0.5	+1.8	+0.6	−0.2	−0.4	−3.4
Missouri Valley	−0.3	−0.3	−1.0	0.0	−2.3	+1.1	−1.6	−1.6	+1.0	+0.2	−0.1	−0.2	−5.1
Northern slope	−0.4	−0.3	−0.4	0.0	−0.6	+0.3	−0.2	+0.2	+0.7	+0.7	−0.3	0.0	−0.3
Middle slope	−0.3	−0.5	−0.8	0.0	−2.0	−0.7	+0.1	0.0	+1.3	0.0	+0.5	−0.3	−2.7
Southern slope	−0.4	−0.8	−0.8	+0.2	+1.2	−1.3	+0.7	−0.4	+1.3	+0.3	−0.5	−0.6	−1.1
Southern plateau	−0.6	−0.6	−0.2	−0.1	+0.1	−0.2	−0.3	−0.2	0.0	+0.6	−0.3	−0.1	−1.9
Middle plateau	−0.7	0.0	−0.1	+0.1	−0.2	+0.8	+0.3	+0.7	+0.5	+0.7	−0.1	−0.3	+2.2
Northern plateau	−0.2	−0.4	−0.8	−0.1	0.0	+0.1	+0.3	+0.3	+0.2	−0.5	−0.5	−0.4	−2.0
North Pacific coast region	−0.1	+0.5	−1.9	−0.1	−0.7	−0.9	−0.5	+0.4	−1.0	−2.9	−1.9	−0.4	−9.5
Middle Pacific coast region	−2.8	+2.1	−1.8	+0.8	+1.2	−0.1	0.0	+0.1	+0.4	−1.0	−1.1	−2.2	−4.4
South Pacific coast region	−1.8	−0.8	−0.3	+0.8	+0.7	+0.1	0.0	0.0	−0.2	+0.8	−0.7	0.0	−1.4
United States	−0.2	−0.6	−1.0	−0.4	−0.6	−0.4	−0.1	−0.8	+0.1	+0.4	+0.1	−0.6	−4.1

TROPICAL CYCLONES DURING 1925

By W. P. DAY

Only three tropical disturbances which might be classed as hurricanes were observed in the Caribbean Sea, the Gulf of Mexico, and the adjacent waters of the Atlantic. At the same time four important storms were experienced on the Pacific south of Mexico, and several other individual reports of gales were received from vessels in that region and south of Central America.

On the 3d of June a tropical disturbance was experienced in the Pacific south of the Gulf of Tehuantepec. It moved slowly northwestward during the next three days, striking the Mexican coast west of Salina Cruz on the 7th. It was apparently only of moderate intensity.

At 2 a. m. on July 10, the S. S. *San Tiburcio* in the Pacific near latitude 15° N. and longitude 112° W. encountered a severe hurricane, the barometer reading as low as 28.90 inches.

The S. S. *Antinous* at 2.30 a. m. of August 20 in latitude 34° 38′ N. and 63° 05′ W. passed near the center of a small hurricane. The lowest reading of the barometer was 29.34 inches and the highest wind was force 12 (Beaufort). This storm began to form in the remnants of a low-pressure trough on the 18th, about half-way between Bermuda and the Florida Peninsula, moved thence slowly northeastward and apparently reached its greatest intensity while in the vicinity of the S. S. *Antinous*. It merged with a more extensive disturbance to the north, but could still be identified on the morning of the 21st near latitude 41° N. and longitude 52° W.

On the 5th of September the S. S. *Baja California* in the southwestern Gulf of Mexico experienced a storm with winds shifting from north through east to southeast. The storm moved rapidly northwest to the mouth of the Rio Grande by the evening of the 6th, and caused heavy rains and moderate gales over the lower Rio Grande valley. Again, from the 12th to the 16th of September a tropical disturbance of considerable intensity moved west-northwest along the southern Mexican coast, causing gales from the Gulf of Tehuantepec to Cape Corrientes.

During October the only important tropical disturbance was a hurricane apparently of considerable intensity, which developed off the southern Mexican coast about the 22d and passed inland near Cape Correintes on the 25th.

The only important hurricane affecting the United States took form in the northwestern Caribbean Sea on November 29, crossed the Florida Peninsula and extreme eastern North Carolina, turned eastward across the Atlantic and was last noted on the 9th of December after passing the Azores. The lowest barometer reading reported in this storm was 28.90 inches, by the U.S.S. *Patoka*, near the North Carolina coast on the 2d of December. A complete account of this hurricane will be found under the heading, "Storms and Weather Warnings," in this issue of the REVIEW. The appearance of a true hurricane so late in the season is of particular interest.

NOTES, ABSTRACTS, AND REVIEWS

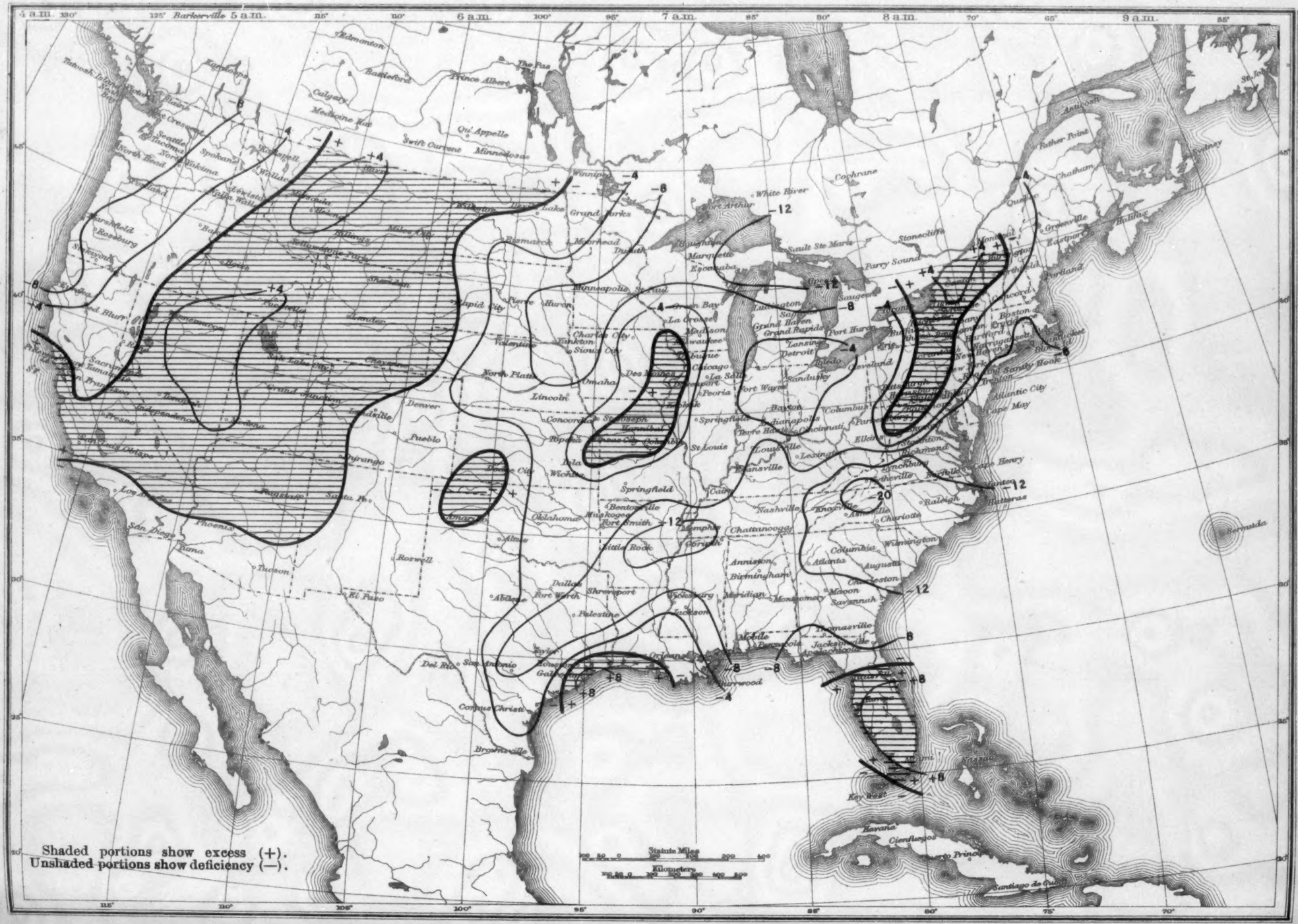
"THE CLIMATES OF THE UNITED STATES"

The publication by Ginn and Co. of Ward's "The Climates of the United States" was the outstanding climatological event in this country in 1925. Those who have had the privilege of receiving instruction from its author will recognize in the book the same qualities which make his teaching of climatology incomparable. Clarity of thought, directness and restraint of statement, inevitably march together through its pages. Consequently it is about as invulnerable to criticism as a book could be. Yet there are certain phases of it which will or will not, according to the reader's temperament, engender the wish that they might have been different.

Ward paints his climatic pictures in broad strokes. The wisdom of this can not be doubted. But in such procedure lies the danger that generalization of statement may at rare interv ls sli over the line and become weakness of statement, the danger that the student will be left with an impression that the book fails in

XIV. Annual Temperature Departures (°F.) in the United States, 1925

XV. Annual Precipitation Departures (inches) in the United States, 1925



some slight degree to provide all that he might reasonably expect of it. Thus in speaking of mountain climates (p. 19), they are characterized as having "usually a greater frequency of rain and snow and, up to a certain altitude, more of it." To the reviewer, that is a disappointing sentence. It would have been so easy to say—and at no risk of cumbering the text with detail—, "up to altitudes, usually of some thousands of feet, which vary according to location, exposure and slope." To be sure, a concrete example is given on p. 181, but in the meantime much good might have been accomplished by intimating to the reader that this altitude is not fixed and by exciting his curiosity as to why it varies.

Again, one can not help seriously questioning the advisability of omitting climatological tables. To exclude them from the body of the text seems most wise, but not to present them at all seems, in view of the "smoothing" of nearly all the maps and graphs, unwise. This is generalization carried to the point of giving us a climatology without a climatological table. Though the splendid compilation of bibliographic material leaves no uncertainty as to where such tables may be found, nevertheless the reviewer feels that for the sake of those to whom such sources are not conveniently available, compact climatological tables should have been provided. For this is the one book which anyone interested either directly or indirectly in the climates of the United States will find indispensable—*the* source of information on this subject to own if one can have but one.

On a very few points the critical reader might be inclined to differ with the author's views in matters of interpretation. I think, for instance, that Ward's zeal in combating the fallacy which would ascribe to ocean currents powers over climate which they do not possess, results in failure to present some important aspects of the case. And is it quibbling to suggest that if "climate is most briefly defined as *average weather*" (p. 11), then the assertion (p. 21) that "an ocean current can have practically no influence on the climate of an adjacent land unless the wind is blowing on shore" is scarcely justifiable?

That Ward's book will find a wide and increasing field of usefulness is inevitable. Every teacher and student of climatology and geography will, of course, find in it a *sine qua non;* but so also will that great group of readers who, be they scientists or not, realize the value of extending their outlook beyond their more immediate concerns, in this case to an appreciation of the significance of climate in human affairs.—*Burton M. Varney.*

EXNER ON WORLD PRESSURE AND TEMPERATURE ANOMALIES; WAGNER ON A 16-YEAR PERIOD IN TEMPERATURE

[Reprints from Science Abstracts, no. 332, Aug. 25, 1925]

1836. *Monthly Pressure and Temperature Anomalies over the Earth. Correlation of Pressures of Iceland with other Places.* F. M. Exner. (Akad. Wiss. Wien, Ber. 133. 2a. No. 7–8. pp. 307–408, 1924.)—The present work forms an extension of earlier calculations [Abstract 605 (1914)] to cover a longer period, 1887–1916, and to cover the whole earth. Results have been obtained from 71 stations for pressure and 72 for temperature, mainly from year-books, but a quantity of hitherto unpublished information was used. Mostly results were available over the whole 30 years for each place, but in a few cases corrected results from neighboring stations were introduced. In parts of the Southern Hemispere and between the equator and 10° N. shorter series had to be employed. Over the whole series for pressure and temperature deviations from the mean were obtained for each month and for the year, the deviations being called anomalies. These results are set out by arranging the stations in belts of 10° of latitude. Charts give the geographical distribution of the pressure and temperature anomalies in February and August. In February pressure anomalies in the Northern Hemisphere are a maximum, but in the Southern Hemisphere a minimum, the reverse holding for August. Temperature anomalies for the Southern Hemisphere are greatest in August and least in February, the reverse holding for the Northern Hemisphere. The regions where pressure and temperature anomalies have their greatest values are called centers of action. The three most prominent of these regions are those where influxes of polar air are likely to occur, that is the northern part of the north Atlantic, northwest Asia, and the Behring Straits, the first of these being subdivided into the Icelandic and the Labrador regions. Finally, the pressure at Stykkisholm, Iceland, the place with the maximum pressure anomalies, is correlated with that at each of the other 70 stations for each month in the whole period and for the winter and summer half years, that is, October–March and April–September, these two latter being charted. A summary shows a large negative correlation in the region 30°–50° N. existing throughout the year, but generally in South latitudes the correlation is small. Further work is contemplated over the regions of zero correlation. An appendix gives the source of the information for each station and values of the pressure and temperature anomalies for each month and year of the series and also 30-year mean values for each month, the stations being arranged in alphabetical order.—*R. S. R.*

1841. *A Remarkable Sixteen-Yearly Climatic Period and Other Possible Periods.* A. Wagner. (Akad. Wiss. Wien, Ber. 133. 2a. No. 5–6. pp. 169–224, 1925.)—The author has first investigated the temperatures obtained at Vienna over the interval 1776–1919, and is able to confirm the existence of a period of 16 years for the temperature difference between the summer and the preceeding winter. The results are extended when examining a series of stations in middle and south Europe, but along a line Stykkisholm-Stockholm-Petrograd this period is lost. South of this line the phase is the same as that at Vienna, but north of the line it is reversed. The amplitude is a maximum in mid-Europe and decreases gradually north and south. Stations in mid-Europe and those in the north show the 16-yearly period in both summer and winter mean temperatures, but with opposite phases, and the winter amplitudes is about double the summer one. At the maximum of the period in middle and south Europe a severe winter and a warm summer occur, and these relations are reversed at the minimum. At mountain stations a larger amplitude is found than for a valley station in the same latitude. In an appendix, periods of 33.8, 3.5, and 3 years are investigated for the same series of observations. The Vienna periodograms confirm the existence of the 33.8 and 3 yearly periods for the same temperature difference as used above, but for other European stations it is less definite. In the region where the 16-yearly period is lost and its phase reversed, an 8-yearly period is very probable, but for other parts of Europe this period can not be detected with certainty.—*R. S. R.*

RESIGNATION OF FATHER ALGUÉ FROM THE PHILIPPINE WEATHER BUREAU

We have received the following note from Sr. Miguel Selga, Acting Director, under date of December 7, 1925:

I regret to announce the resignation of Rev. José Algué, as Director of the Weather Bureau of the Philippine Islands, effective December 31, 1925. Father Algué left Manila for Spain on September 14, 1924; poor health and failing eyesight prompted his resignation.

The above note indicates the withdrawal from active service of a distinguished meteorologist. Father Algué went to the Manila Observatory some 30 years ago from Habana, and subsequently became its director. In this capacity in 1900 he reorganized the weather service of the Philippines, inaugurating the use of methods and apparatus in accordance with the practice of the U. S. Weather Bureau. From that time, the record of the Philippine Weather Bureau under his guidance has been one of increasingly important service, particularly in the study and forecasting of tropical hurricanes in that part of the world. Father Algué's great contribution to the literature of tropical storms is his well-known "Cyclones of the Far East," published in Manila in 1904.—*B. M. V.*

METEOROLOGICAL SERVICE FOR THE REPUBLIC OF TURKEY

We are in receipt of information from Dr. Anton Réthly, formerly of the Hungarian Meteorological and Magnetic Institute and Secretary of the Hungarian Meteorological Society, indicating that he is in Angora proceeding with the establishment of the new Turkish meteorological service. The following extracts are translated from his letter:

My institute is attached to the Ministry of Agriculture. * * * The first steps are to establish an observatory at Angora and to issue monthly bulletins beginning with that for November; to enter into relations with the Constantinople observatory (which is independent, and, properly speaking, an astronomical institution), and the erection of an observatory in the summer of 1926 at Erzerum. The setting up of 12 stations, 6 of the first order and 6 of the second, together with 50 rainfall stations, is contemplated for the following year, and from then on the establishment of 15 meteorological stations annually, and 50 rain-gage stations in the interest not only of the climatology of the country but of agriculture and hydrography as well.

FOOTNOTES AND CITATIONS IN CONTRIBUTIONS TO THE MONTHLY WEATHER REVIEW

In order that the REVIEW may comply with a request that the scientific publications of the Department of Agriculture adhere to a uniform procedure in the matter of footnotes and citations, the editor bespeaks the cooperation of contributors in following a somewhat different plan than that in effect heretofore. In the following memorandum, "footnotes" are understood to mean all comments not requiring a reference to literature, and a "citation" is a reference to literature without comment by the contributor.

Hitherto both footnotes and citations have usually been referred to by means of superior numbers (numbers placed above the line) in the text, and have run consecutively from beginning to end of a given contribution. In future, the following practice will be followed:

Footnotes will be indicated as heretofore by superior numbers referring to corresponding superior numbers which stand at the head of footnotes in the body of the manuscript between broken lines to set them off from the body of the text. These footnotes will be numbered consecutively from beginning to end of the contribution. They will form a series quite apart from the citations.

Citations of literature will be made by placing numbers in parentheses in the line of text, the numbers running consecutively from beginning to end of the contribution, and referring to a list at the end of the contribution called "Literature Cited." Each entry in this list will preferably be composed of author's name, year of publication, title of article, and reference to journal in which it may be found, arranged as follows:

LITERATURE CITED

(1) BLAIR, T. A.
1917. SOME TEMPERATURE CORRELATIONS IN THE UNITED STATES. Mo. Wea. Rev., 45: 444.

(2) WALKER, SIR G. T.
1924. CORRELATIONS IN SEASONAL WEATHER. Memoirs of the Indian Met'l. Dept., 24: parts 4 and 9.

A combination of footnote and citation will sometimes be desirable. The citation number should in that case be accompanied by a footnote number, in the text, though the citation number need not appear in the footnote.

The new plan is being followed for the first time in the December, 1925, issue of the MONTHLY WEATHER REVIEW, to which readers are referred for examples.—*B. M. V.*

EDITORIAL REVISION

It is deeply gratifying to the editors of the REVIEW to note the spirit of cooperation shown by the great majority of contributors in discussing editorial changes in their manuscripts. The problem of revision is a delicate one. It requires that the editors shall be constantly vigilant lest in their endeavor to assist the author toward clear and concise expression they shall inject some turn of thought not desired by him. Over 30 years ago the late Prof. Cleveland Abbe expressed so well the point of view we try to maintain, that we reprint his note here in full:

The authors whose papers appear in the MONTHLY WEATHER REVIEW will sometimes observe that changes have been made in their phraseology, sentences have been omitted, textual matter converted into tabular matter, explanatory notes added by the Editor, etc. As these changes have been made in good faith and under the conviction that they avoid introducing problematic questions, make the text of the article clearer, and increase its value to the readers of the REVIEW, therefore the Editor hopes they will not be taken amiss, and that his changes will not be considered as a case of officious meddling. No one can have the interests of the REVIEW more thoroughly at heart than the Editor. His duty is to make it a medium of instruction to all. Whenever practicable, suggested changes in manuscript have been referred back to the respective authors for their approval, but in a few cases this has not been practicable. In all cases the aim has been, not to put new ideas and words into an author's text, but to simply restate clearly the position that each author takes in reference to his own subject.

METEOROLOGICAL SUMMARY FOR SOUTHERN SOUTH AMERICA, DECEMBER, 1925

[Abstract of report by Señor J. B. Navarrete, El Salto Observatory, Santiago, Chile]

December in general was characterized by atmosphiric instability in far southern South America, due to the frequent passage of depressions.

Though anticyclonic conditions held until the 3d, thereafter a succession of LOWS, with but one HIGH on the 10th-11th intervening, gave unsettled weather, rains and winds until the 17th. The situation was then reversed, anticyclonic weather until the 30th being interrupted by only one important depression, on the 22d and 23d.

In general, while the above mentioned cyclonic activity characterized the more southerly area of the South Pacific, central Chile enjoyed prevailingly fine weather, with temperatures reaching 30°C. to 33°C. (86°F. to 91.4°F.) in the shade.—*B. M. V.*

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Vattenstånden vid rikets kuster åren 1887–1921. Stockholm. 1925. 85 p. 31½ cm. (Med. Statens met.-hydrog. anstalt. Bd. 2, N:o 4.)

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Untersuchungen über die Elemente des Nebels und der Wolken. Stockholm. 1925. 73 p. figs. plates. 32½ cm. (Med. Statens met.-hydrog. anstalt. Bd. 2, N:o 5.)

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING DECEMBER, 1925

By HERBERT H. KIMBALL, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements the reader is referred to the REVIEW for January, 1924, **52**: 42, and January, 1925, **53**: 29.

From Table 1 it is seen that solar radiation intensities averaged slightly above December normals except at Madison, Wis., where few intensities were measured.

Table 2 shows that the total solar and sky radiation received on a horizontal surface averaged slightly above the December normal at Washington and slightly below the normal at the other two stations.

For the year Table 2 shows a slight deficiency in radiation at all three stations, which, however, at Washington and Madison is less than the deficiency for October at these stations, and at Lincoln exceeds the October deficiency but little.

Skylight polarization measurements made at Washington on five days give a mean of 64 per cent, with a maximum of 69 per cent on the 18th. These are above the corresponding December averages for Washington. At Madison no sky polarization measurements were made during the month, as the ground was covered with snow.

TABLE 1.—*Solar radiation intensities during December, 1925*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Dec. 7	2.03	0.89	0.99	1.16	1.38			1.17	1.03	0.91	2.49
8	3.00				1.29						3.00
10	2.26	0.87	1.00	1.15	1.43			1.11	0.92	0.77	1.78
12	4.17				1.11			0.97	0.93	0.80	3.81
14	2.16							0.71			2.62
18	2.74	0.65	0.79	0.94	1.25			1.09	0.92	0.77	2.26
23	1.68	0.78	0.94	1.12	1.27						1.37
28	0.96				1.25			1.08	0.93	0.80	1.32
29	1.32	0.79	0.86	0.95	1.16			1.01	0.89		1.32
31	1.60			0.83	1.17			0.98			1.78
Means		0.80	0.92	1.02	1.26			1.02	0.94	0.81	
Departures		+0.02	+0.03	−0.03	+0.04			+0.01	+0.04	+0.03	

Extrapolated.

TABLE 1.—*Solar radiation intensities during December, 1925*—Con.

[Gram-calories per minute per square centimeter of normal surface]

Madison, Wis.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Dec. 9	3.00	0.95									2.87
10	1.78			1.13				1.19			1.96
14	1.88			1.09							2.49
18	0.96			1.09							1.37
19	3.30			1.02	1.20						3.63
26	0.51			1.19							0.48
Means		(0.95)		1.10	(1.20)			(1.19)			
Departures		−0.01		−0.11				−0.09			

Lincoln, Nebr.

Dec. 5	1.60	1.02	1.17	1.30							1.88
8	4.17							1.21	1.08	0.96	5.56
9	4.17			1.00				1.26	1.14	1.04	5.56
11	3.81	1.00	1.14	1.28	1.44			1.26	1.10	0.99	5.56
12	3.81							1.17	1.06	0.90	4.95
15	2.36							1.22	1.12	1.06	2.16
18	2.74	0.75	0.89	1.10				1.14	1.03	0.94	4.17
19	3.00	0.89	1.04	1.20							3.15
22	1.45	1.03	1.16	1.30	1.47			1.28	1.15	1.02	1.52
31	2.26	0.95	1.07	1.25				1.25	1.14	1.04	3.15
Means		0.94	1.06	1.20	(1.46)			1.22	1.10	0.99	
Departures		±0.00	+0.02	−0.03	+0.09			+0.01	+0.02	+0.03	

[1] Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation: Washington	Madison	Lincoln	Chicago	New York	Average daily departure from normal: Washington	Madison	Lincoln
1925	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Dec. 3	130	79	165	38	75	−16	−42	−11
10	163	117	164	47	124	+20	−6	−8
17	133	110	153	39	74	−10	−17	−21
24[1]	156	158	184	67	112	+10	+26	+6
Deficiency for the year						−959	−254	−2,310

[1] Eight-day period.

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

December followed the example of the two previous months in being unusually stormy, with the percentage of days of winds of gale force considerably above the normal over the greater part of the ocean, and especially so in southern waters. The greatest number of gales occurred in the 5-degree square between 45° and 50° N., and 30° and 35° W., where they were reported on 12 days.

Judging from reports received, the number of days with fog was considerably below the normal over the Grand Banks, the steamer lanes, and off the European coast. Fog was also somewhat less frequent than usual off the American coast, but was reported on two days in the Gulf of Mexico.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressures at sea level, 8 a. m. (75th meridian), North Atlantic Ocean, December, 1925*

Stations	Average pressure	Departure [1]	Highest	Date	Lowest	Date
	Inches	*Inches*	*Inches*		*Inches*	
St. Johns, Newfoundland	29.55	−0.27	30.50	2d	28.40	24th.
Nantucket	29.84	−0.25	30.32	1st [2]	29.34	12th.
Hatteras	29.99	−0.15	30.54	29th	29.52	2d.
Key West	30.05	−0.04	30.32	23d	29.80	1st.
New Orleans	30.13	+0.01	30.68	28th	29.68	4th.
Swan Island	29.90	−0.08	30.02	23d [2]	29.82	1st. [2]
Turks Island	30.06	+0.03	30.18	29th [2]	29.92	Do. [2]
Bermuda	30.05	−0.10	30.32	24th	29.74	10th.
Horta, Azores	29.76	−0.38	30.16	14th [2]	28.94	4th.
Lerwick, Shetland Islands	29.53	−0.19	30.43	4th	28.51	29th.
Valencia, Ireland	29.71	−0.24	30.45	16th	28.71	20th.
London	29.78	−0.24	30.44	5th	28.63	Do.

[1] From normals shown on H. O. Pilot Chart, based on observations at Greenwich mean noon, or 7 a. m., 75th meridian.
[2] And on other dates.

Unusually low pressure prevailed at the majority of the stations. At Horta a barometer reading of 28.12 inches was reported on the evening of the 3d, accompanied by a westerly wind of approximately 90 miles an hour, while the average reading for the first decade of the month was 29.55 inches. There were also two other disturbances of lesser intensity during the month in the vicinity of the Azores and the intrusion of low pressure into the region usually occupied by the North Atlantic HIGH was responsible for much of the abnormal weather over the ocean.

Charts VIII to XII, which cover the period from the 1st to 5th inclusive, show most unusual conditions for a winter month, with the tropical disturbance, described elsewhere in the REVIEW, and the severe and extensive disturbance in the vicinity of the Azores. On the 6th the center of the latter was near 47° N., 22° W.; it had decreased somewhat in intensity and extent although moderate to strong gales still prevailed over the middle and eastern sections of the steamer lanes. On the 7th this depression was central about 5 degrees west of the south coast of Ireland, and on the 8th to 10th over the North Sea. On the latter date moderate weather prevailed over the eastern portion of the ocean, while from the 7th to 9th gales were encountered east of the 30th meridian. On the 8th there was a secondary LOW central over the western islands of the Azores that drifted slowly northeastward, gradually filling in, and on the 10th the center was near 41° N., 24° W., with light to moderate winds over the eastern section of the ocean.

On the 7th and 8th northeasterly to northwesterly winds, force 7, were reported from the Gulf of Mexico.

On the 9th Father Point was near the center of a LOW that moved slowly eastward until the 11th, when it was off the east coast of Newfoundland. Between these dates moderate to strong westerly gales were encountered west of the 40th meridian, the storm area reaching its greatest extent on the 11th. On the 12th and 13th the center was near 40° N., 30° W., and on these dates the area had contracted considerably and covered a limited region near the center of the low.

On the 12th there was also a depression over Maine and Quebec that moved slowly eastward and on the 16th and 17th was central near St. Johns, Newfoundland, while from the 14th to 16th westerly gales were reported by vessels in the southerly quadrants.

On the 16th there was a LOW near 47° N., 35° W., that moved very slowly eastward and on the 22d was over the British Isles. From the 18th to 21st the storm area extended as far south as the Azores, where westerly gales with low barometric readings prevailed. On the 17th and 18th an extensive area of low pressure was over the western section of the steamer lanes, that by the 19th had apparently joined forces with the eastern LOW. On these two former dates a few scattering reports were received indicating moderate gales between the 30th and 45th parallels and 35th and 55th meridians.

On the 19th and 20th low pressure prevailed in the Gulf of Mexico and on the former date gales were reported by vessels in the region between the west coast of Florida and the 90th meridian.

On the 20th there was a disturbance along the American coast between Chesapeake Bay and Hatteras that moved slowly northeastward and on the 23d was central near Sydney, N. S. On the 21st it was accompanied by moderate weather, but by the 23d heavy northwesterly gales prevailed between Hatteras and Nantucket. By the 24th this LOW had developed considerably and was central near 48° N., 47° W., while strong gales prevailed over the greater part of the steamer lanes, attaining hurricane force near the center. On the 25th, with the center near 50° N., 40° W., violent westerly gales continued over an extensive region between the 40th and 55th parallels, west of the 20th meridian.

On the 27th and 28th there were two marked depressions, the first central off the coast of Newfoundland and the second in the vicinity of the British Isles. On the latter date storm reports were received from vessels in practically all parts of the ocean between the 30th and 50th parallels. On the 28th there was a "norther" in the Gulf of Mexico, the wind attaining a maximum force of 9; this was due to the steep pressure gradient, as the barometer readings were 30.68 inches at New Orleans, 30.72 inches at Galveston, and 29.96 inches at Swan Island.

On the 29th stormy weather still prevailed east of the 50th meridian, while over the western section of the ocean moderate winds were the rule. By the 30th the storm area had contracted considerably and was now restricted to that section of the steamer lanes east of the 40th meridian. On this date moderate northwesterly gales were also reported by vessels between the Bermudas and 55th meridian.

On the 31st the third disturbance of the month surrounded the Azores, and at the morning observation at Horta a southerly wind, force 8, with a barometric reading of 29.76 inches, was reported. On this date westerly gales were encountered as far west as the 50th meridian, while moderate weather prevailed over the northern steamer lanes.

OCEAN GALES AND STORMS, DECEMBER, 1925

Vessel	Voyage From—	Voyage To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
New Jersey, Am. S. S.	Norfolk	Port Arthur	27 39 N.	79 02 W.	Nov. 30	4 a. 1st	1st	29.42	ENE.	SW., 11	WNW.	SW., 11	NE.-SE.-SW.-W.
Virginia, Am. S. S.	Port Arthur	Bayonne	29 10 N.	81 10 W.	29th	Noon, 1st	3d	29.33	NE.	NW., —	W.	—, 12	NE.-NW.-W.
Manchuria, Am. S. S.	San Francisco	New York	36 50 N.	73 23 W.	29th	3 a., 2d	3d	29.72	NE.	ENE., 12	SE.	E 12	NE.-E.
Samaria, Br. S. S.	Liverpool	do.	47 30 N.	37 15 W.	Dec. 2	1 p., 2d	3d	29.69	N	NNW., 7	NNW.	NNW., 10	
Suveric, Br. S. S.	Oran	Philadelphia	38 25 N.	74 46 W.	2d	3 a., 3d	3d	29.61	ENE.	ENE., 10	E.	ENE., 11	Steady.
Superga, Ital. S. S.	France	Louisiana	33 36 N.	36 36 W.	3d	4 a., 3d	5d	29.39	SW.	SW., 10	NW.	—, 11	SW.-NW.
Gedania, Danzig S. S.	Baltimore	Tampico	22 35 N.	96 50 W.	4th	6 a., 4th	4th	29.77	NNW.	N., —	N.	—, 9	Steady.
Eibergen, Du. S. S.	Rotterdam	New York	49 18 N.	27 27 W.	2d	4 p., 4th	6th	29.00	E.	NNE., 11	N.	NNE., 11	Do.
Wellfield, Br. M. S.	Dublin	New Orleans	37 30 N.	37 27 W.	2d	1 a., 4th	5th	29.18	NW.	N., 12	W.	N., 12	Do.
War Nizam, Br. S. S.	Curaçao	Rotterdam	43 20 N.	24 W.	4th	Noon, 4th	4th	28.18	SSE.	S., 11	W.	S., 11	SSE.-W.
St. Andrew, Br. S. S.	Hull	Galveston	48 01 N.	27 54 W.	4th	11 a., 4th	6th	28.35	N.	N., 9	N.	W., 10	N.-W.
Kerhonkson, Am. S. S.	Belfast	Baltimore	52 15 N.	34 30 W.	4th	4 a., 5th	6th	29.13	NE.	NNE., —	NNW.	NNE., 10	Steady.
Liberty Land, Am. S. S.	Huelva	New York	41 30 N.	23 59 W.	2d	4 p., 5th	6th	28.84	S.	SW., 11	W.	SW., 12	SSW.-WSW.
Hoosac, Br. S. S.	Liverpool	Boston	51 25 N.	12 W.	7th	8 p., 7th	9th	29.11	SSW.	SW., —	NW.	—, 11	SSW.-SW.
Laura C., Ital. S. S.	Gibraltar	New York	33 01 N.	24 35 W.	8th	8 a., 8th	9th	29.75	S.	S., 9	W.	S., 9	
Colorado Springs, Am. S. S.	London	New Orleans	38 54 N.	26 36 W.	9th	8 a., 9th	9th	29.37	SE.	SW., 8	W.	N., 10	SE.-W.
Montpelier, Am. S. S.	Hamburg	New York	42 12 N.	60 15 W.	9th	8 a., 9th	11th	29.12	SW.	SW., 10	W.	SW., 10	SW.-WSW.
Brush, Am. S. S.	Galveston	Bremen	38 53 N.	62 22 W.	10th	4 p., 10th	11th	29.46	W.	NW., 9	NW.	NW., 10	W.-NW.-N.-NW
Mijdrecht, Du. S. S.	New York	Vigo	43 32 N.	41 10 W.	10th	5 a., 11th	11th	29.55	S.	SSE., 10		SSE., 10	S.-SSE.
Nitonian, Br. S. S.	Antwerp	New York	48 07 N.	31 52 W.	12th	4 p., 12th	13th	29.65	SE.	NW., 7	NW.	N., 9	S.-NW.
Parthenia, Br. S. S.	Avonmouth	St. John, N.B.	43 07 N.	61 50 W.	14th	8 a., 14th	15th	29.52	WNW.	WNW., 10	NW.	—, 10	
Kamesit, Am. S. S.	Liverpool	Bermuda	43 35 N.	24 50 W.	16th	7 a., 16th	17th	29.92	SE.	SE., 10	SSW.	SE., 10	SW.-WSW.
Laura C., Ital. S. S.	Gibraltar	New York	33 02 N.	58 30 W.	17th	10 a., 17th	18th	29.59	SW.	SW., 9	NW.	SW., 9	
Idaho, Br. S. S.	New York	Hull	43 38 N.	46 17 W.	18th	3 p., 18th	20th	28.76	WSW.	WSW., 12	WNW.	WSW., 12	E.-WSW.-NW.
Salina, Ital. S. S.	Italy	Charleston, S. C.	35 20 N.	48 20 W.	18th	2 a., 18th	19th	29.60	WSW.	WSW., 10	NW.	NW., 11	
Osaa, Am. S. S.	New York	Malta	41 45 N.	33 10 W.	18th	1 a., 19th	20th	28.69	SE.	SW., 12	WNW.	SW., 12	S.-SW.-W.
Hastings, Am. S. S.	Liverpool	Pensacola	29 20 N.	87 03 W.	19th	9 a., 19th	19th	29.64	ENE.	W., —	W.	NW., 10	ENE.-NW.
Eastern Victor, Am. S. S.	Rotterdam	Philadelphia	42 12 N.	29 20 W.	18th	8 a., 19th	21st	28.55	SSE.	SW., 12	WSW.	SW., 12	Steady.
San Mateo, Am. S. S.	New York	West Indies	36 50 N.	73 54 W.	20th	8 a., 20th	20th	29.63	SSW.	SSW., —	W.	SW., 9	SSW.-SW.
Howick Hall, Am. S. S.	Rio de Janeiro	Baltimore	34 38 N.	72 27 W.	22d	11 p., 22d	23d	29.60	SW.	W., 9	N.	—, 10	W.-N.
Vardulia, Br. S. S.	London	New York	43 42 N.	57 20 W.	23d	Noon, 23d	25th	28.60	SW.	SW., 12	NW.	SW., 12	S.-W.-NW.
Ampetco, Belg. S. S.	Antwerp	Baton Rouge	44 46 N.	43 50 W.	23d	2 p., 23d	26th	28.92	SSE.	WSW., 11	W.	W., 11	SSE.-SW.-W.
Stockholm, Swed. S. S.	Gothenburg	New York	47 50 N.	50 10 W.	23d	7 a., 24th	26th	27.95	S.	W., 11	W.	W., 11	
Gudrun Maersk, Dan. S. S.	Rotterdam	do.	50 32 N.	36 10 W.	24th	4 p., 24th	30th	28.15	S.	SW., 9	W.	W., 12	W.-NW.
Persephone, Danzig S. S.	Hamburg	do.	48 47 N.	47 28 W.	23d	8 a., 24th	26th	28.12	SE.	SE., 10	W.	W., 11	SW.-WSW.
Eastern Victor, Am. S. S.	Rotterdam	Philadelphia	36 35 N.	50 20 W.	26th	9 a., 27th	29th	29.62	SW.	SW., 8	NW.	W., 10	Steady.
Londonier, Belg. S. S.	New York	Antwerp	40 50 N.	56 39 W.	28th	2 p., 28th	28th	29.11	NW.	NW., 9	NW.	—, 10	
Boston City, Br. S. S.	do.	Cardiff	48 30 N.	33 W.	28th	1 p., 28th	28th	29.02	S.	W., —	WSW.	W., 12	
Arminco, Belg. S. S.	Norfolk	Rouen	47 03 N.	34 30 W.	28th	9 a., 29th	30th	28.78	SE.	SE., 10	W.	—, 12	SE.-S.-SSW.-WNW.
Malakuta, Br. S. S.	London	Port Said	48 34 N.	5 39 W.	28th	4 p., 30th	31st	29.24	SW.	SW., 9	S.	SW., 11	Steady.
NORTH PACIFIC OCEAN													
Tascalusa, Br. S. S.	Hongkong	San Francisco	37 38 N.	146 42 W.	1st	8 p., 2d	3d	29.88	S.	S., 8	S.	S., 8	Steady.
Pres. Lincoln, Am. S. S.	San Francisco	Manila	34 N.	132 30 W.	1st	8 p., 1st	2d	29.76	N.	N., 7	N.	N., 8	NE.-NNW.
Indiana, Fr. S. S.	Panama	Portland, Oreg.	38 10 N.	125 22 W.	2d	4 a., 2d	3d	29.90	NW.	NW., 10	N.	NW., 10	
Akibasan Maru, Jap. S. S.	Otaru	San Francisco	49 24 N.	166 47 W.	3d	6 p., 8th	12th	28.95	ESE.	NE., 10	SSW.	NE., 10 SE., 10	
Asuka Maru, Jap. S. S.	Yokohama	Seattle	47 53 N.	179 32 W.	4th	8 p., 5th	5th	28.94	SE.	E., 8	E.	ESE., 9	SE.-E.
Volunteer, Am. S. S.	Honolulu	Kobe	*33 02 N.	*136 30 E.	5th		6th					WNW., 10	
Steel Age, Am. S. S.	Yokohama	San Pedro	35 04 N.	170 40 E.	5th	10 p., 6th	11th	29.30	WNW.	SSW., 6	W.	—, 9	S.-SSW.
West Jena, Am. S. S.	Portland	Orient	37 47 N.	144 24 E.	6th	7 a.	6th	29.52	NE.	NE., 7	NNW.	N., 10	NE.-N.
Stanley Dollar, Am. S. S.	Nagasaki	San Francisco	43 N.	159 30 E.	7th		8th	29.39	NNE.	NNE., —	WNW.	NNW., 8	NNE.-NNW.
Africa Maru, Jap. S. S.	Yokohama	Victoria	49 57 N.	166 29 W.	8th	8 p., 8th	10th	29.00	NNE.	NE., 9	N.	NE., 9	NE.-N.
Stockton, Am. S. S.	Cebu, P. I.	Portland	48 N.	171 20 W.	7th	6 p., 8th	10th	28.96	E.	NE., 9	N.	NE., 11	4 points.
Dickenson, Am. S. S.	Honolulu	Midway Island.	28 13 N.	177 23 W.	10th	1 p., 16th	22d	29.30	SW.	SW., 7	NNW.	NW., 10	SW.-NW.
Emp. of Australia, Br. S. S.	Yokohama	Vancouver	50 15 N.	165 57 W.	11th	4 p., 12th	13th	29.44	NE.	NE., 9	NNW.	NNE., 10	NE.-N.-NNW.
Levant Arrow, Am. S. S.	Shanghai	San Pedro	Yokohama Bay		15th	4 a., 16th	19th	29.56	SW.	SW., 10	NW.	SW., 10	Steady.
Meiko Maru, Jap. S. S.	Milke, Japan	Vancouver	47 08 N.	162 53 E.	16th	7 a., 19th	19th	28.87	SE.	SE., 10	WSW.	ESE., 11	
Enterprise, Am. S. S.	San Francisco	Hilo	34 15 N.	131 02 W.	17th	8 p., 17th	18th	29.93	WNW.	—, 9		NNW., 9	Steady.
Edgemoor, Am. S. S.	Balboa	Honolulu	21 16 N.	154 03 W.	19th	4 p.	19th	29.58	S.	S., 8	S.	S., 8	Do.
Dewey, Am. S. S.	Oregon	Kobe	43 17 N.	159 14 E.	18th	Noon, 18th	24th	28.89	SSE.	SSE., 11	NW.	W., 12	SSE.-SW.-NW.
Niagara, Br. S. S.	Vancouver	Honolulu	44 32 N.	132 34 W.	18th	8 a., 18th	23d	29.25	WSW.	NW., 7	WSW.	S., 10	WSW.-W.
Wilhelmina, Am. S. S.	San Francisco	do.	25 18 N.	151 45 W.	21st	4 p., 22d	22d	29.67	S.	SSE., 8	W.	SSE., 9	Steady.
Hellenic, Swed. S. S.	Cebu	Mororan	*41 48 N.	*141 18 E.	21st	10 p., 22d	23d	28.66	ESE.	WNW., 7	WNW.	E., 12 W., 12	NW.-WNW.
Storviken, Nor. S. S.	Shanghai	Vancouver	35 04 N.	143 44 E.	20th	6 p., 21st	24th	28.99	E.	SW., 8	W.	—, 9	SE.-S.-SW.
West Jessup, Am. S. S.	Oregon	Yokohama	52 19 N.	165 10 W.	20th	3 a., 24th	24th	28.93	ENE.	N., 8	NNW.	N., 8	NE.-N.-NNW.
Lancaster, Am. S. S.	Panama	San Francisco	13 N.	93 14 W.	23d	Noon, 23d	24th	29.77	N.	N., —	N.	N., 11	Steady.
Salina, Am. S. S.	Los Angeles	Honolulu	29 40 N.	136 W.	25th	4 a., 26th	26th	29.30	S.	S., 7		S., 10	
Matsonia, Am. S. S.	San Francisco	do.	33 19 N.	136 01 W.	25th	8 p., 25th	26th	29.62	S.	SSE., 8	W.	SSE., 9	
West Jessup, Am. S. S.	Oregon	Yokohama	48 11 N.	160 55 E.	30th	9 p., 30th	31st	29.63	SE.	SE., 8	WNW.	SE., 8	SE.-S.-WSW.
Meiko Maru, Jap. S. S.	Milke	Vancouver	50 36 N.	141 10 W.	30th	10 p., 30th	31st	29.31	ESE.	S., 10	WSW.	S., 10	

* Approximate.

NORTH PACIFIC OCEAN

By WILLIS EDWIN HURD

A chart showing the average positions of the cyclones and anticyclones over the North Pacific Ocean during December, 1925, reveals some abnormal as well as normal features. There was the usual high pressure area over the China coast and adjacent seas, and comparatively low pressure over central and northern Japan and thence for some distance seaward. Off the coast of middle California the North Pacific HIGH averaged normal, but to the westward somewhat below normal; it did not cover as great an area between the Hawaiian Islands and the mainland as usual, due to active cyclones from the west and north spreading farther eastward and southward than is ordinarily the case. At Honolulu the pressure was 0.07 inch below normal, while at Midway Island it reached 0.21 inch below. From this general region of low pressure, extending north-northeastward, lay a deepening cyclonic trough culminating in a LOW, deeper than usual for December, and central over the northwestern part of the Gulf of Alaska, near Kodiak. West of this region there was no secondary depression of the Aleutian cyclone this month, pressure being normal at Dutch Harbor and becoming considerably above normal to the westward and northward, particularly toward the Pribilof Islands. Between St. Paul and Kodiak the mean pressure difference was 0.31 inch, the former averaging 0.18 inch above normal; the latter, 0.13 inch below. Normally the difference is only 0.03.

The table herewith shows the pressures, and their differences from the average, for the several island and coast stations.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressures at sea level at indicated hours, North Pacific Ocean, December, 1925*

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Dutch Harbor [1]	29.58	0.00	30.28	17th	28.96	28th.
Saint Paul [1]	29.79	+0.18	30.50	do [5]	29.14	21st.
Kodiak [1]	29.45	−0.13	29.98	12th	28.98	14th.
Midway Island [1 2]	29.83	−0.21	30.14	30th	29.32	16th.
Honolulu [3]	29.94	−0.07	30.06	9th	29.64	19th.
Juneau [3]	29.69	−0.10	30.23	26th	29.06	1st.
Tatoosh Island [3 4]	30.03	+0.06	30.39	5th	29.35	17th.
San Francisco [3 4]	30.11	0.00	30.37	4th	29.74	1st.
San Diego [3 4]	30.01	−0.03	30.23	do	29.81	2d.

[1] P. m. observations only.
[2] 30 days.
[3] A. m. and p. m. observations.
[4] Corrected to 24-hour mean.
[5] Also on 18th.

During more than 20 days the weather of Midway Island and vicinity was affected by cyclones, the first of which was experienced at the beginning of the month. There was considerable wind activity on several days; the highest velocity reported was force 9, NW., on the 21st. The American cable steamer *Dickenson*, lying off Midway during a great part of December, reported gales and much drizzly weather from the 10th to the 22d. On the 18th large hail stones, mingled with excessive rain, fell during a terrific squall. Though the center of the cyclone affecting the island on these dates had moved well toward the Aleutians by the end of the month, it continued to influence the weather at Midway until the 29th.

Between the Hawaiian Islands and our west coast there were several days of rough weather, due partly to the southward spread of the cyclone central over the Gulf of Alaska, and partly to the eastward extension of the great cyclone just mentioned. Strong gales were experienced east and northeast of Hawaii from the 19th to the 22d, and strong to whole gales near the middle of the San Francisco-Hawaii route on several days between the 17th and the 26th—being most widespread on the 25th and 26th.

At Honolulu southwest (kona) winds occurred from the 18th to the 22d, and a heavy kona rain, amounting to 1.40 inches, fell on the 18th. The maximum wind velocity was 37 SW. on the 21st, but velocities of 36 SW. and 35 SW. occurred on the 20th and 22d, respectively. The prevailing wind at this station continued to be, as heretofore for several months, from the east.

In the American Tropics gales were reported by vessels in the Gulf of Tehuantepec on the 23d, 24th, and 29th. The 23d and 24th the American steamer *Lancaster* encountered whole gales to storm winds from the north.

On the 11th a maximum wind velocity of 75 miles an hour from the south was recorded at Tatoosh Island, the storm center being over southeastern Alaska.

Along the northern sailing routes gales seem to have been comparatively infrequent east of the 170th meridian of west longitude. West of this meridian the weather was stormier, with more frequent gales. Between the Japanese coast and the meridian of 160° E. storm to hurricane velocities were reported on the 16th, 18th, 21st, and 22d, those of the 21st and 22d being due to a typhoon which was crossing the islands of Japan. This storm was experienced by the Swedish steamer *Hellenic*, Capt. Carl Camp, Cebu to Mororan, while in and near 40° 54′ N., 141° 48′ E. The quotation is from the report of the third officer, Mr. B. Peterzan:

> December 21, 3 p. m.; barometer 29.85. The wind and sea moved to east and increased to a violent hurricane, with hard breaking sea.
>
> 12 midnight. Barometer 29.66 and dropping fast. The wind reached its highest velocity between 12 and 2 a. m., and was accompanied by tremendous squalls.
>
> December 22, 2 a. m. Barometer 29.51. The wind suddenly died out. Above the ship the sky was clear and the stars shone bright. Round the eastern horizon much lightning. This calm period was about 25 minutes' duration, then the wind turned right over to west and came with the force as before. The sky overcast again.
>
> 4.50 p. m. Ship in port. Barometer still going down, and it reached the lowest point, 10 p. m., 28.66, then began to raise fast. Weather squally with snow and rain.

Concerning another typhoon in the Far East, see the following report by the Rev. José Coronas, S. J., of the Manila Observatory.

Fog was of frequent occurrence off the central California coast. It was observed on a number of days over the southern waters of the Gulf of Alaska, and occasionally south of the easternmost islands of the Aleutian chain, but no report of its occurrence west of the 180th meridian has yet been received.

TYPHOONS AND DEPRESSIONS

A TYPHOON OVER YAP IN DECEMBER, 1925

By Rev. José CORONAS, S. J.

[Weather Bureau, Manila, P. I.]

This typhoon was shown for the first time on our weather maps on December 14 to the south of Guam, in about 145° longitude E., between 8° and 9° latitude N. It moved W. on the 14th, and passed over or very close to Yap in the afternoon or evening of the 15th. The last weather report received from that station was

that of 2 p. m. of the 15th with a barometric reading 743.8 mm. (29.28 ins.) and a strong gale from NNE. The communication with Yap was then interrupted, and up to the present no information has been received from our observer there, although news has reached us to the effect that our meteorological station was practically destroyed by the typhoon.

Observations from the U. S. A. T. *Chaumont*, on her way from Guam to the Philippines, show clearly that the typhoon recurved gradually to the N. and NE. after passing over Yap. The barometric minimum observed on the *Chaumont* was 749.5 mm. (29.51 ins.) on the 18th, while a strong gale was blowing from the SE.

The approximate position of the center at 6 a. m. and 2 p. m. of the 17th to 20th was as follows:

	°	′		°	′	
December 17, 6 a. m.	132	35	longitude E.,	10	50	latitude N.
December 17, 2 p. m.	131	30	longitude E.,	11	30	latitude N.
December 18, 6 a. m.	130	35	longitude E.,	12	40	latitude N.
December 18, 2 p. m.	130	30	longitude E.,	13	00	latitude N.
December 19, 6 a. m.	130	20	longitude E.,	13	40	latitude N.
December 19, 2 p. m.	130	20	longitude E.,	13	50	latitude N.
December 20, 6 a. m.	130	40	longitude E.,	15	40	latitude N.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

The outstanding features of the pressure distribution were as follows: The continental extension of the North Pacific statistical anticyclone was centered over the Great Basin with pressure 30.30 inches or higher on 19 days; pressure in the oceanic part of this anticyclone was considerably diminished and was probably 0.20 inch below normal values. Coincidently with decreased pressure over the ocean, continental over western United States were higher than usual. The continuity of the high pressure over the Great Basin was interrupted in the last half of the month, thus facilitating the development and movement of cyclonic storms in lower latitudes. Several such storms converged over the North Atlantic in the neighborhood of the Grand Bank where very low pressure was registered.

In the United States the single outstanding cold spell was inaugurated by the southward movement of high pressure as shown in Chart I.

The usual details follow.

CYCLONES AND ANTICYCLONES

By W. P. DAY

The number of both low-pressure and high-pressure areas was below the normal for December. There were 13 LOWS as compared with 18 for November and 23 for October, and the 8 HIGHS were the least number occurring in any month during the year. A persistent Plateau HIGH with extensions to the southeast, continuing from the 3d to the 11th, shielded the country from the rather active Pacific LOWS; and when the Plateau HIGH finally gave way, it was succeeded by two great HIGHS from the Canadian interior which successively occupied much of the country. The second and larger of the two covered practically the entire interior of the continent from the 26th until the 31st, and of course no LOWS of importance were charted during this interval.

FREE-AIR SUMMARY

By V. E. JAKL

The mean free-air temperatures were below normal at all aerological stations except Drexel and Ellendale, where they were approximate normal at the former station and slightly above at the latter. (See Table 1.) Observed departures aloft were, moreover, about the same as at the surface. Their geographical distribution is therefore quite well represented by the map of surface temperature departures, Chart III in this REVIEW.

The greatest negative departure was at Groesbeck, where the resultant winds (Table 2) were generally northwesterly, instead of about west-southwest, as is normal for the altitudes usually obtained there. At those other stations where negative temperature departures were also recorded, the excess of northerly component (or lack of southerly component) as compared with the normal, was not so pronounced as at Groesbeck; in some cases, as at Royal Center, the deviation from the normal was barely perceptible.

The general wind resultants derived from both balloon and kite observations were northwesterly, varying, however, from more nearly westerly to decidedly northwesterly with increase in altitude and latitude. Westerly winds aloft were dominant in the lower latitudes as far south as Key West, where above 2,000 meters the prevailing winds were of moderate force from almost due west. At this station the winds had an easterly component up to about 1,000 meters, above which there was a transition zone of southerly winds extending to about 2,000 meters. San Francisco also showed winds with an easterly component in the lower levels, but to a slightly greater depth than at Key West. Easterly components are not apparent in the resultants from observations at any of the other stations. Resultant velocities were close to normal at all levels at practically all stations.

The northern stations showed, as usual for the time of year, decided temperature inversions at levels of moderate height (about 1,500 meters). They were most pronounced at Ellendale, where at 1,500 meters the average temperature was 3.2° higher than on the ground. The average inversion at Ellendale was accumulated for the most in the first decade of the month, when temperatures were usually considerably above normal, owing to cold periods being of but short duration. Typical inversions occurred, for instance, on the 10th, when it was 12° warmer at 1,200 meters than on the ground. On the 31st temperature increased with altitude from −16.8° on the ground to 7.1° at 2,000 meters, and decreased thence to −13.4° at 5,000 meters. These were well-defined examples of the reaction to warmer with free-air winds of south component, following a change to colder with northerly winds. This condition is always productive of large inversions due to the southwesterly to westerly winds aloft bringing higher temperatures more rapidly than the southerly wind near the ground which is mostly dependent on insolation for raising the temeprature at the place of observation.

In the latter part of the month, when the cold was more intense and more persistent, the vertical temperature gradients showed a tendency to a more nearly isothermal state. Thus at Ellendale and Drexel, on the 26th and 27th, respectively, the effects of a pronounced HIGH on the vertical temperature gradient are shown by the following figures: Ellendale on the 26th: Ground, −22.3°; 900 meters, −26.1°; 2,000 meters, −20.9°; 2,600 meters, −22.4°. Drexel on the 27th: Ground, −22.8°; 1,200 meters, −26.1°; 2,000 meters, −17.5°;

3,600 meters, −22.2°. In both these cases the station lay in front of, and close to, the crest of the HIGH.

Relative humidities were about normal at all levels for all stations, and varied little from station to station. Consequently vapor pressures were greatest at those stations that had the highest mean temperatures. However, the total precipitation at the various stations showed but little relation to this factor of moisture content. Thus, at Drexel the total precipitation for the month was six times that at Ellendale and nearly three times that at Groesbeck.

A diurnal series of observations made at Due West on the 1st and 2d is of interest in view of the proximity of that station to the hurricane that was passing up the Atlantic coast on those dates. As the later flights of the series were curtailed owing to stormy conditions impending, the records of only the 1st and last flights are reproduced for comparison, and appear in the following table:

Altitude m. s. l. (meters)	Temperature	Relative humidity	Wind		Temperature	Relative humidity	Wind	
			Direction	Velocity			Direction	Velocity
	Dec. 1				Dec. 2			
	° C.	Per cent			° C.	Per cent		
Surface (217)	3.7	73	NE.	7	10.9	58	NNE.	10
500	5.1	82	NE.	11	8.4	62	NE.	18
1,000	8.8	41	NNE.	11	10.2	62	NNE.	18
1,500	6.6	43	NE.	9	8.0	78	NE.	16
2,000	2.3	52	NE.	8	4.3	91	NE.	16
3,000	−2.0	42	NE.	9				
4,000	−5.4	35	N.	9				
5,000			N.	9				
6,000			N.	8				

The record of the 1st, to which have been added wind data from the simultaneous pilot-balloon observation of that date for levels above 4,000 meters, shows that although Due West was just outside of the periphery of the LOW northwest of its center, wind velocities up to 6,000 meters were not especially affected. This is in contrast to conditions to the rear of intense extratropical LOWS, where it is frequently observed that a station apparently outside of its influence, so far as surface isobars indicate, shows high velocities aloft. The change to higher humidities and stronger winds attending the approach of the hurricane center is shown in the record of the 2d.

The most pronounced instance of high velocities aloft occurred on the 31st at Broken Arrow and Due West, where double and single theodolite observations respectively showed 56 m.p.s. from the west at 11,000 meters at the former station, and 66 m.p.s. from the west-northwest at 7,000 meters at the latter. This wind was a natural consequence of the south-to-north pressure gradient as shown by the surface map, and its coincidence with the temperature gradient shown by free-air observations.

TABLE 1.—*Free-air temperatures, relative humidities and vapor pressures during December, 1925*

TEMPERATURE (° C.)

Altitude m. s. l. (meters)	Broken Arrow, Okla. (233 meters)		Drexel, Nebr. (396 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)	
	Mean	Departure from 8-yr. mean	Mean	Departure from 11-yr. mean	Mean	Departure from 5-yr. mean	Mean	Departure from 8-yr. mean	Mean	Departure from 8-yr. mean	Mean	Departure from 8-yr. mean
Surface	2.4	−2.4	−4.2	+0.1	6.8	−2.0	−8.0	+0.5	5.0	−4.4	−4.2	−2.5
250	2.4	−2.4			6.9	−1.9			5.0	−4.2	−4.3	−2.5
500	2.9	−1.4	−4.4	−0.2	7.2	−1.4	−8.3	+0.1	4.5	−4.2	−5.8	−2.8
750	2.7	−1.5	−3.8	−0.1	7.0	−1.3	−7.8	−0.2	3.8	−4.7	−6.4	−3.0
1,000	2.5	−2.2	−3.1	−0.2	6.3	−1.5	−6.0	+0.5	4.1	−4.5	−5.9	−2.5
1,250	2.4	−2.4	−2.9	−0.4	5.5	−1.6	−4.8	+1.1	4.3	−4.0	−5.6	−2.2
1,500	1.9	−2.6	−2.7	−0.1	4.6	−1.6	−4.8	+1.2	3.9	−3.8	−5.6	−2.1
2,000	0.4	−2.7	−3.8	+0.2	2.7	−1.8	−5.9	+1.3	2.7	−3.5	−7.0	−2.1
2,500	−1.5	−2.5	−5.9	+0.4	0.7	−1.9	−8.1	+1.2	1.1	−3.0	−9.0	−2.2
3,000	−3.7	−2.3	−8.1	+0.6	−0.7	−1.3	−10.4	+1.5	−0.4	−2.2	−11.3	−2.2
3,500	−6.0	−2.1	−10.4	+0.8	−2.8	−1.2	−12.7	+2.0	−2.9	−2.1	−14.0	−2.1
4,000	−8.8	−2.2	−13.3	+0.6	−5.0	−0.4	−15.2	+2.3	−6.1	−2.6	−17.0	−1.9
4,500	−12.0	−2.6	−16.3	+0.5			−19.5	+0.6	−9.9	−4.0	−20.6	−1.9
5,000	−15.3	−2.3	−19.9	+0.5								

RELATIVE HUMIDITY (%)

Surface	69	−2	74	−3	70	−4	83	+2	67	−7	81	+1
250	69	−2			68	−5			63	−9	81	+1
500	62	−3	72	−2	69	−8	82	+3	59	−9	80	+3
750	57	−3	67	+1	56	−8	75	+3	58	−6	74	+2
1,000	53	0	64	+1	56	−6	65	0	53	−5	63	−2
1,250	49	+2	61	+2	55	−5	60	0	52	−2	56	−3
1,500	47	+4	59	+2	55	−4	56	−1	52	+2	52	−3
2,000	42	+4	58	+3	52	−3	53	−1	46	+4	48	+4
2,500	40	+3	60	+4	49	−1	51	−3	43	+5	45	+6
3,000	38	+1	62	+5	33	−9	46	−7	43	+8	47	+4
3,500	30	+2	60	+3	32	−11	44	−8	40	+8	40	+7
4,000	40	+4	60	+3	32	−12	40	−11	50	+18	64	+7
4,500	40	+4	59	+1			43	−4	59	+27	81	+7
5,000	36	+2	58	+1								

VAPOR PRESSURE (*mb.*)

Surface	5.32	−1.22	3.55	−0.14	7.15	−1.85	3.04	+0.17	6.50	−3.18	3.84	−0.80
250	5.29	−1.19			7.10	−1.81			6.15	−3.18	3.78	−0.80
500	4.88	−0.87	3.42	−0.11	6.50	−1.70	2.92	+0.10	5.49	−3.03	3.28	−0.73
750	4.42	−0.77	3.27	−0.01	5.99	−1.64	2.74	+0.08	5.06	−2.70	2.83	−0.76
1,000	4.00	−0.62	3.24	+0.12	5.68	−1.39	2.70	+0.16	4.60	−2.25	2.46	−0.77
1,250	3.64	−0.46	3.15	+0.18	5.36	−1.16	2.61	+0.18	4.49	−1.59	2.23	−0.68
1,500	3.40	−0.30	3.05	+0.25	5.04	−0.93	2.50	+0.22	4.38	−0.93	2.01	−0.56
2,000	2.58	−0.38	2.71	+0.30	4.13	−0.69	2.17	+0.23	3.65	−0.25	1.74	−0.51
2,500	2.07	−0.38	2.22	+0.21	3.38	−0.53	1.77	+0.13	3.16	+0.19	1.54	−0.40
3,000	1.69	−0.45	1.95	+0.20	1.95	−1.03	1.31	0.60	2.81	+0.49	1.44	−0.24
3,500	1.43	−0.38	1.53	+0.09	1.77	−0.57	0.99	−0.03	2.26	+0.56	1.28	−0.19
4,000	1.23	−0.33	1.18	+0.04	1.49	−0.57	0.75	−0.08	2.45	+1.03	1.26	+0.03
4,500	0.89	−0.45	0.83	−0.03			0.61	−0.01	2.39	+1.18	1.03	+0.03
5,000	0.56	−0.57	0.57	−0.07								

TABLE 2.—*Free-air resultant winds (m. p. s.) during December, 1925*

Altitude m. s. l. (meters)	Broken Arrow, Okla. (233 meters)				Drexel, Nebr. (396 meters)				Due West, S. C. (217 meters)				Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)			
	Mean		8-year mean		Mean		11-year mean		Mean		5-year mean		Mean		8-year mean		Mean		8-year mean		Mean		8-year mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 76°W	1.8	S. 57°W	1.2	N. 42°W	1.8	N. 85°W	1.1	N. 81°W	2.4	S. 69°W	1.4	N. 27°W	3.7	N. 51°W	3.5	N. 38°W	2.3	N. 75°W	1.1	S. 75°W	3.3	S. 56°W	2.3
250	S. 74°W	1.8	S. 50°W	1.3					S. 35°W	1.7	S. 60°W	1.6					N. 47°W	2.3	S. 82°W	1.4	S. 75°W	3.4	S. 55°W	2.6
500	S. 68°W	3.3	S. 48°W	3.2	N. 57°W	2.6	N. 84°W	2.0	S. 75°W	2.8	S. 62°W	3.5	N. 32°W	4.0	N. 57°W	3.8	N. 57°W	3.1	S. 60°W	2.6	S. 73°W	6.8	S. 60°W	5.6
750	S. 80°W	4.3	S. 52°W	4.1	N. 55°W	5.4	N. 75°W	3.8	W.		S. 70°W	5.0	N. 26°W	5.4	N. 56°W	5.8	N. 64°W	3.8	S. 59°W	3.7	S. 77°W	8.0	S. 68°W	7.2
1,000	S. 88°W	5.4	S. 67°W	4.7	N. 61°W	6.2	N. 74°W	4.9	N. 78°W	5.1	S. 76°W	6.5	N. 23°W	6.2	N. 53°W	7.0	N. 64°W	4.5	S. 60°W	5.1	S. 83°W	9.8	S. 79°W	8.4
1,250	N. 88°W	5.9	S. 79°W	5.2	N. 47°W	7.4	N. 73°W	5.7	N. 71°W	7.1	S. 76°W	7.9	N. 20°W	7.1	N. 64°W	7.6	N. 67°W	4.3	S. 65°W	9.1	S. 84°W	10.7	S. 83°W	10.1
1,500	N. 85°W	6.9	S. 81°W	6.0	N. 49°W	7.3	N. 76°W	7.1	N. 75°W	8.3	S. 84°W	9.1	N. 20°W	7.1	N. 55°W	8.5	N. 57°W	5.2	S. 68°W	7.0	N. 80°W	10.8	S. 88°W	11.0
2,000	N. 88°W	7.9	S. 83°W	7.4	N. 59°W	8.3	N. 78°W	9.0	N. 83°W	9.2	S. 85°W	10.3	N. 34°W	9.3	N. 57°W	10.1	N. 68°W	6.8	S. 73°W	8.2	N. 87°W	13.7	N. 88°W	12.7
2,500	N. 88°W	9.0	S. 87°W	9.5	N. 59°W	9.0	N. 78°W	11.3	S. 77°W	7.7	S. 88°W	11.2	N. 33°W	10.0	N. 60°W	11.8	N. 80°W	8.2	S. 76°W	9.6	N. 84°W	15.6	N. 86°W	14.3
3,000	N. 80°W	10.4	N. 89°W	10.8	N. 67°W	10.1	N. 78°W	13.6	N. 78°W	9.7	N. 86°W	13.3	N. 38°W	12.8	N. 63°W	13.3	N. 78°W	9.6	S. 76°W	11.4	N. 79°W	16.4	N. 89°W	14.6
3,500	N. 78°W	12.6	N. 87°W	12.1	N. 52°W	11.3	N. 79°W	14.9	N. 66°W	12.2	N. 86°W	13.9	N. 47°W	13.3	N. 69°W	14.7	N. 78°W	10.6	S. 77°W	11.8	N. 86°W	20.4	N. 86°W	13.3
4,000	N. 77°W	13.9	N. 81°W	12.0	N. 59°W	8.7	N. 83°W	15.6	N. 56°W	9.0	N. 83°W	12.3	N. 27°W	13.8	N. 68°W	13.9	N. 82°W	12.4	S. 79°W	11.5	S. 22°W	17.0	S. 66°W	13.4
4,500	S. 88°W	10.4	N. 82°W	12.2	N. 51°W	9.0	N. 71°W	15.6					N. 59°W	15.3	W.		N. 67°W	14.8	N. 67°W	15.6	N. 85°W	12.1	S. 22°W	16.0	S. 64°W	7.8
5,000	N. 54°W	12.8	N. 71°W	14.1	N. 55°W	10.6	N. 79°W	16.6					N. 67°W	20.9	N. 82°W	15.6	N. 67°W	17.1	N. 81°W	14.6				

NAVAL AIR STATION D. C.

TABLE 3.—*Mean free-air temperatures, humidities, and vapor pressures, and resultant winds (m. p. s.) during December, 1925, at Washington, D. C.*

Altitude m. s. l. (meters)	Naval Air Station, D. C. (7 meters)			Weather Bureau (34 meters)	
				Wind	
	Temperature	Relative humidity	Vapor pressure	Direction	Velocity
	°C.	Per cent	mb.		m. p. s.
Surface	0.5	70	4.54	N. 58° W.	2.8
250	0.5	67	4.37	N. 60° W.	6.0
500	−0.8	68	4.00	N. 60° W.	9.2
750	−2.2	68	3.61	N. 59° W.	12.5
1,000	−2.8	63	3.13	N. 77° W.	12.6
1,250	−3.5	63	2.88		
1,500	−4.1	65	2.78	N. 61° W.	15.1
2,000	−5.1	68	2.50	N. 59° W.	18.0
2,500	−6.7	66	2.09	N. 69° W.	18.2
3,000	−8.9	65	1.58	N. 71° W.	19.0

THE WEATHER ELEMENTS

By P. C. DAY, In Charge of Division

PRESSURE AND WINDS

While the weather of the month was mainly devoid of spectacular features, nevertheless, important variations from the normal atmospheric circulation greatly influenced the temperature and precipitation conditions.

First in importance was the persistence of an anticyclone of more than average proportions over the Plateau region during the first half, maintained apparently without reinforcement from more northern areas, and devoid largely of the tendency to induce low temperatures usually associated with areas of high pressure.

The fact that temperatures over that region were materially above normal was probably largely due to the absence of any considerable snow cover, a condition which would prevent excessive night radiation from causing subnormal temperatures.

As is usually the case when high barometric pressure prevails over the Plateau and Pacific Coast States, storms moving toward that region from the North Pacific were forced inland over British Columbia or southern Alaska and entered the United States mainly to eastward of the Rocky Mountains. As a result, little snow or rain occurred in California and adjacent areas. East of the Rocky Mountains cyclones were inclined to move eastward along the northern border, particularly during the first half. However, the most important precipitation of the month occurred in connection with storms having their origin in the South or Southwest.

The severe tropical storm moving northward along the Atlantic coast at the first of the month gave heavy rains over the area, and a storm central in Kansas on the morning of the 3d moved eastward to the Mississippi Valley and thence northward to the Great Lakes during the following 48 hours, giving widespread moderate precipitation in the central valleys and most eastern districts. About the middle of the month some heavy rains occurred in the lower Mississippi Valley and Gulf States and again near the end of the second decade there was widespread precipitation over central and eastern districts, though the falls were mainly light except in portions of the East Gulf States. Otherwise there was little important cyclonic activity except along the northern border, but here the storms afforded rather light precipitation, as is frequently the case.

The first important anticyclone of the month, moving into the United States from the Canadian northwest, appeared on the morning of the 21st in the upper Missouri Valley and moved rapidly southward over the Great Plains to Texas and thence eastward over the Gulf States to the Florida Peninsula, giving some of the lowest temperatures of the month in the Southern States. On Christmas day the first indication of the most widespread and important anticyclone and cold wave of the month was noted in the far Canadian northwest, and by the following morning it had entered the United States, carrying the line of zero temperature into central Iowa. During the following 24 hours it developed marked intensity, the barometer rising above 31 inches in portions of the upper Missouri Valley, and the line of zero temperature reached as far south as central Missouri and southern Kentucky. During the following 24 hours the cold advanced into the West Gulf States with freezing temperatures in extreme southern Texas, to the coast line of the Gulf States, and into central Florida. In portions of the Middle Gulf States, temperatures during this period were the lowest ever recorded so early in the winter and much damage resulted to truck and tender vegetables, not only there but in southern Texas and other portions of the Gulf and South Atlantic States. This anticyclone gradually overspread the eastern districts and the coldest weather of the month was registered over the greater part of country during its passage southward and eastward.

The average pressures were distinctly high over the Northwest and correspondingly low over New England and the Canadian Maritime Provinces, the monthly sea-level means ranging from 30.32 inches at Boise, Idaho, to 29.71 at Father Point, Quebec.

From the Great Plains westward to the Pacific, except over portions of central and southern California, the average pressures were above normal and they were likewise above over the adjacent Canadian Provinces. Over the eastern half of the United States, and of Canada as well, the pressure averages were everywhere less than normal and decidedly so in the more eastern districts.

The wind circulation responded to the pressure distribution and was mainly from westerly points over the eastern third of the country, due to the marked depression of the barometer to the eastward. In the west they were controlled mainly by the high pressure over the northern Plateau, blowing from the northwest over the Missouri Valley and Great Plains, and largely from southerly points over the Pacific Coast States, except in portions of California where they were frequently from the northwest. Some high winds prevailed over the Atlantic coast districts during the passage northward of the tropical storm early in the month and again on the 23d, and some high winds occurred in the Lake region on the 5th and 6th. Otherwise high winds were infrequent and notably so on the Pacific coast where December is usually a windy month. At a few points along the north Atlantic coast and over the eastern end of Lake Erie the monthly wind movement was the highest of record for December, due not to excessive high winds on particular dates but to steady blows for long periods.

A list of the more important storms of the month appears at the end of this section.

TEMPERATURE

During the greater part of the month temperature changes were mainly unimportant except in a few local areas, but it was distinctly cold over the southern por-

tions during the latter half, and over all districts from the Rocky Mountains eastward during the last week. West of the Rocky Mountains the weather was moderately warm throughout the month, in fact portions of the far Northwest had the highest averages ever known in December and at local points in eastern Washington and western Montana the temperature was above normal every day in the month. Similar warmth appears to have existed in western Canada, where the monthly averages were far above normal, and reports from Alaska indicate the temperatures were frequently unseasonably high over much of that Territory, and later reports indicate that this condition has continued into the New Year. From the Great Plains eastward, and generally over the Southern States, the temperature averages were below normal save in portions of the North Atlantic States, the maritime portions of Canada, and extreme southern Florida, where the month averaged slightly warmer than normal. The mildest period of the month was mainly during the first week from the Mississippi Valley eastward, except in the Gulf States where the 13th and 14th were the warmest days, and about this time it was warm in the Southwest and portions of the far Northwest.

The lowest temperatures from the Rocky Mountains eastward were associated with the severe cold wave about the 26th to 28th, though at a few points in the lower Mississippi Valley the 23d was the coldest day. West of the Rocky Mountains the last two or three days were the coldest, though locally in New Mexico the 4th was the coldest day, and in California and Arizona the 20th and 21st were coldest.

PRECIPITATION

Considering the country as a whole, precipitation was deficient in nearly all the States, and even where in excess the margins above normal were small save in Florida and locally along the south Atlantic coast, where the excesses were mainly due to the heavy rains attending the tropical storm of the 1st and 2d. Over the middle and West Gulf States and thence northeast to the Ohio Valley the deficiency ranged from 1 to 3 inches and locally in this area the monthly amounts were the least of record for December. In the far West precipitation was everywhere less than usually falls in December, save along the immediate coast districts of Washington and in one or two other small areas where the monthly falls were equal to or slightly more than normal. Over most of California and parts of Oregon and other near-by States the deficiencies were large.

SNOWFALL

Generally there was less snowfall than usually occurs in the first winter month, though in a few localities the amounts were comparatively large, notably in southeastern Wyoming and thence eastward over Nebraska to Iowa. High winds attending or following the snowfall in this area caused much drifting and interference with traffic, some roads being closed until the end of the month.

Although snowfall was mainly light it had a wide distribution, measurable amounts occurring in extreme southern Texas, where locally it was associated with sleet or ice storms, which caused considerable damage to overhead wires, trees, and shrubbery.

In the western mountain areas the snowfall was nearly everywhere light, particularly in the areas where much dependence is placed upon the early storage of snow for a supply of water during the coming summer. In California and nearby districts the snow was remarkably light and the depths on ground in the mountains were far less than usual at the end of December. In fact, many sections of the high Sierra, usually deeply covered, were entirely bare at the end of the month.

Due to continued moderate warmth, ice did not form of sufficient thickness for harvest in the large commercial districts until after the severe cold near the end of the month.

RELATIVE HUMIDITY

The relative amount of atmospheric moisture was largely deficient over practically all southern districts and generally over the Atlantic Coast States. From the Great Lakes and Ohio Valley westward to the Pacific there was mainly a slight excess.

SEVERE LOCAL HAIL AND WIND STORMS, DECEMBER, 1925

[This table contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Florida	1						Recorded in November REVIEW as of Nov. 30-Dec. 1.	
Marshall, Ark. (near)	3	11 p. m.	50		$3,500	Tornado	Storm moved from southwest to northeast over path 5 miles long; dwellings and barns damaged.	Official, U. S. Weather Bureau.
New Jersey coast	3			2		Continuation of tropical disturbance noted Nov 30 over Florida.	Bulkheads, boardwalks, and other structures washed out or otherwise damaged by wind and waves; considerable loss and delay to navigation.	Official, U. S. Weather Bureau; the Evening World (New York, N. Y.).
Yazoo City, Miss	4	5:10 a. m.		2	500,000	Violent wind, probably tornado.	About 100 houses destroyed and 25 persons injured.	Official, U. S. Weather Bureau.
Calloway, Marshall, Livingston, Lyon, and Caldwell Counties, Ky.	4	A. m.	50-1,320	2	75,000	Series of storms of tornadic character.	Many houses unroofed; several wrecked; extensive property damage at Murray, Kuttawa, and Princeton; considerable loss to telephone and telegraph companies.	Do.
Posey and Gibson Counties, Ind.	4	A. m.				High wind	A few buildings unroofed; some crop damage; several persons injured by flying glass.	Do.
Cairo, Ill	4					Wind and electrical.	Minor damage reported	Do.
North-central counties, Mo.	4					High wind and snow.	Railway trains much behind schedule; public highways made impassable by drifted snow.	Do.
St. Paul, Minn., and vicinity	4					High winds	Two miles of wires blown down; trains delayed.	Pioneer Press (St. Paul, Minn.).
Kansas City, Mo	13-14				7,800	Glaze	Much damage to wires, trees, shrubbery, and other exposed objects; 350 breaks in telephone wires; some delay to traffic.	Official, U. S. Weather Bureau.
Northern Iowa	24					Strong wind and snow.	Many highways temporarily blocked, resulting in some delay to traffic.	Do.
Western Lower Michigan and sections of Upper Michigan	25-27					High winds and snow.	Snow drifted by winds caused blockade of roads; no damage reported.	Do.

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

The tropical cyclone that passed over the Florida Peninsula during the night of November 30–December 1 originated over the northwestern Caribbean Sea and was central a short distance east or southeast of Swan Island at 8 a. m., November 29. It was of slight intensity at this time, but increased rapidly in intensity after passing through the Yucatan Channel during the following night, and by 8 p. m. of the 30th the barometer at Key West, Fla., had fallen to 29.62 inches and the wind had shifted to southwest. The S. S. *El Isleo*, which was some distance northwest of Key West in latitude 25° 18′ N. and longitude 84° 0′ W., reported a barometer reading of 29.60 inches and wind force 10 (whole gale) from the northwest.

During the night of November 30 the center of the storm passed inland south of Tampa. At Tampa the barometer fell to 29.50 inches and the wind reached a maximum velocity of 52 miles from the northeast about 1 a. m. of December 1. At 8 a. m. of December 1 the storm was centered a short distance east of Titusville, and the pressure at the center was somewhat under 29.50 inches. Jacksonville reported a maximum wind velocity of 48 miles from the north. Vessel reports from near the center at noon showed that the storm had attained hurricane intensity. The S. S. *R. W. Stewart* in latitude 29° 40′ N., and longitude 79° 10′ W., reported a barometer reading of 29.30 inches, with a whole gale blowing from the northeast, accompanied by mountainous seas. The S. S. *El Estero*, less than 100 miles to the south-southwest, reported a barometer reading of 29.34 inches and a wind force of 12 (hurricane) from the west. No 8 p. m. vessel reports were received from the vicinity of the hurricane center, which was apparently about 150 miles due east of Savannah, Ga., at that time. The wind had increased to 42 miles an hour at both Savannah and Charleston, but it was only 24 miles an hour at Hatteras. Northeast storm warnings had been ordered displayed from Punta Gorda to Jacksonville, Fla., during the afternoon of November 30 and north of Jacksonville to Boston, Mass., at 9:30 a. m. of December 1. It was stated in the hoist messages of the 1st that the storm would increase in intensity and likely become severe. At 9:30 p. m. of the 1st, whole-gale warnings were ordered displayed from Beaufort, N. C., to the Virginia Capes, and northeast storm warnings were extended north of Boston to Eastport, Me.

At 8 a. m. of the 2d the hurricane was central about 100 miles south-southeast of Wilmington, N. C., the U. S. S. *Patoka* reporting a barometer reading of 28.90 inches with wind force 9 (strong gale) from the east. The storm center passed inland between Wilmington and Cape Hatteras at about 6 p. m., and out to sea again a short distance south of Cape Henry during the night. The northeastward progress of the storm was slowed up and it was deflected toward the east by a strong area of high pressure that had remained almost stationary for several days over the Canadian Maritime Provinces. The storm apparently lost considerable of its intensity as it moved slowly eastward, its center crossing the meridian of Bermuda, but several hundred miles to the north of that island, during the afternoon or night of the 4th.

The subsequent movement of this storm eastward over the ocean was shown by the receipt of wireless reports from the S. S. *American Legion* the morning of the 5th and from the S. S. *Polybius* the evening of the same day. These observations were valuable for the purpose of tracing the movement of this storm, especially as these vessels were in a part of the ocean from which wireless reports are seldom received. Falling pressure and increasing northeast winds at Horta, Azores, during the night of December 7–8 indicated the approach of the storm, and its center passed close to Horta at 4 a. m. of the 9th, with a barometer reading of 29.32 inches and a maximum wind velocity of 40 miles an hour from the northeast. After passing to the northeast of the Azores, this storm apparently merged with another disturbance of wide extent over the North Atlantic.

A very complete report on the damage caused by this storm as it passed over the Florida Peninsula has been prepared by the section director at Jacksonville. The following are extracts from this report:

As a result of the southwest-northeast movement of the storm over the peninsula most of the section east of the Suwannee River felt its force to some extent, chiefly, however, over the peninsula, where trees were uprooted and telephone and telegraph wires were prostrated. Fruit was blown from the trees and much was "thorned"; lowlands were flooded; and, incidentally, much truck was lost. Structures in process of completion suffered considerably; dredges were sunk and many small boats were damaged or sunk at anchor. As a result of the phenomenally high tides and seas damage to beaches and beach property from the mouth of the St. Johns southward was very great—only in millions can the computation be made. In some cases the inroads of the sea exceeded 100 feet. Pavilions, small cottages, and even pretentious structures were undermined, and hotels, whose safety hitherto had never been questioned, were in imminent danger. The extent of the damage from this source is indicated by the fact that $1,000,000 will be required to replace the Jacksonville beaches as they were formerly. There have been higher winds on the coast, and the explanation of the great damage to the Atlantic beaches and beach property is found in the persistence of, and the relatively high, northeast winds, which began at Jacksonville about noon of the 28th and continued until 1 a. m., December 1. The maximum velocity at Jacksonville was 52 miles an hour, setting in with 25 miles on the 28th, 38 miles on the 29th, 34 miles on the 30th, and 52 miles on December 1. The velocities were considerably higher on the coast, from which Jacksonville is distant 17 miles.

Enumeration of marine and other losses is necessarily incomplete, but they were quite severe, due, largely, to the fact that shipping throws caution to the winds, as it were, after the last of October, resting under the Utopian belief that the end of that month marks the close of tropical cyclone activity in these latitudes. Aside from the physical losses there was the more melancholy one—loss of life.

Damage to truck.—This was severe, on account of heavy rain, in the southeast the damage being centered chiefly in the Miami district; losses were not heavy in the Everglades, where the rainfall was much less. Truck suffered severely, also, along the track of the storm as it moved northeastward over the peninsula.

Damage to fruit.—The Citrus Exchange estimated the loss at 300,000 boxes, which, at $2 per box, evidences a formidable sum.

There were very many other losses that can not be enumerated, but in the aggregate they show that the storm approximated the usual disturbance of that character in paralyzing business and damaging marine interests.

The losses of shipping were quite severe, as follows: The American schooner *Arcadia* was sunk; crew of 7 lost. The tug *Gwalia*, towing lumber barge from Mobile, went down. The crew was adrift on the barge; not known if rescued. The American schooner, *William Russell* sank off Fort Lauderdale; crew rescued. The American S. S. *Catopaxi*, Charleston to Cuba, crew of 30, was lost off the southeast coast. A "rum-runner" from Nassau was lost off Daytona Beach; crew of 6 was lost with 2,000 cases of liquor. The pleasure yacht *Miramar*, New York to Miami, was caught in the storm between Charleston and Savannah, December 1; it went down with the crew of 12.

The hurricane described above was only the third tropical storm of known hurricane intensity that developed after November 1 in the North Atlantic Ocean (including the Caribbean Sea and the Gulf of Mexico) since 1886. The first was that of November 17–29, 1888, which caused very severe damage to shipping from Cape Hatteras to Eastport, Me., and the second was the hurricane that devastated the western part of the

island of Jamaica during November 17–18, 1912. The last one is the latest hurricane of record in the North Atlantic during any year since more or less complete vessel reports became available in 1886. Its center passed the Virginia capes early on December 3, which is just a week later in the year than the hurricane of November, 1888, its center passing east of the Virginia capes on November 26. The last named was more severe, however, as it moved northeastward off the coast, and it caused great damage. The December, 1925, hurricane did not cause any great amount of damage, except over the Florida Peninsula; and, furthermore, it decreased in intensity after reaching the North Carolina coast. The highest wind velocity reported from any land station was 64 miles an hour from the northeast at Atlantic City, N. J. Cape Henry, Va., and Block Island, R. I., reported 60 miles an hour from the same direction.

Storm warnings were issued for portions of the Atlantic coast on the 5th, 8th, 9th, 12th, 19th, 22d, 25th, and 27th, and they were verified, as a rule. Velocities in excess of 50 miles an hour were reported from at least one station in connection with four of the storms for which warnings were issued.

Small-craft warnings were issued for limited sections of the Atlantic or east Gulf coasts on the 5th, 13th, 19th, 21st, and 28th. Warnings of northers were sent to the chief hydrographer, Cristobal, Panama Canal Zone, on the 22d and 28th.

No cold-wave warnings were issued until the 22d, when they were ordered for South Carolina, Georgia, extreme eastern Tennessee, extreme western North Carolina, and extreme northern Florida. The severe cold spell of the last week of the month came on rather gradually over parts of the Washington district, but cold-wave warnings were issued the evening of the 26th for Mississippi, Alabama, western Tennessee, and extreme northwestern Florida. The temperature fell to 2° at Anniston, Ala., 18° at Mobile, Ala., and Pensacola, Fla., 12° at Macon, Ga., and 24° at Jacksonville, Fla. At Tampa, Fla., the lowest was 34°.

Frost warnings were issued for portions of the extreme south on 16 dates during the month. On 5 dates warnings were issued for central Florida, the most important of which were those of the 22d and 23d.—*C. L. Mitchell.*

CHICAGO FORECAST DISTRICT

Storm warnings.—Three disturbances that attained storm force more or less generally on the Great Lakes occurred before the closing of the storm warning season on the 15th.

On the morning of the 3d a trough of low pressure covered the Great Plains, with the principal center over southeastern Kansas, and a secondary over northwestern Minnesota. The whole disturbance advanced slowly eastward for about 24 hours, following which it recurved and began to move slowly north-northeastward. After the center reached Lake Michigan the intensity began to diminish. Upon reaching Lake Superior the direction of movement again changed, and an east-northeastward path was taken. General and timely storm warnings were issued for this storm, and in most cases either verifying or near verifying velocities were attained at the regular stations on the Lakes.

On the 8th rather general storm warnings were again issued in connection with a disturbance that had advanced rapidly from the northwest, and with a marked increase in energy as it reached Lake Superior. The storm continued its rapid progress, reaching the mouth of the St. Lawrence River on the morning of the 19th with a still further increase in intensity. On the Great Lakes winds were almost generally of storm force in connection with this disturbance. At Buffalo, N. Y., 66 miles was attained.

The third and final disturbance of the storm warning season prevailed from the 11th to the 14th, inclusive. This storm also advanced to the Great Lakes from the northwest, reaching Lake Superior on the night of the 10th–11th. Thereupon, the storm divided, one portion moving rapidly eastward and the other following in its rear at a slower rate. The warnings issued in this connection were quite general in their scope and were fully justified, verifying velocities occurring at most stations. At Buffalo, N. Y., a maximum velocity of 70 miles an hour was reached.

After the close of the regular storm warning season each year advisory warnings are issued for Lake Michigan whenever the conditions seem to justify. Three warnings of this character were issued for the current month. The warning of the 23d was followed by storm winds and moderate gales on the southern portion of the Lake, but in the other two instances the wind fell short of storm strength.

Cold waves.—A few local cold waves occurred from time to time during the month, but there was no widespread cold wave until the last week when a marked change to colder weather was experienced generally. Cold waves occurred at this time in most of the southern and western portions of the district. The low temperatures were unusually persistent, and it was not until the last day of the month that normal temperatures were again reached in most sections. The attendant high-pressure area was of great magnitude and appeared to have its origin in the region east of Alaska. At Miles City, Mont., the reduced barometer on the morning of the 27th was 31.22 inches.

The only cold wave warnings issued during the month were those on the 8th for northern Minnesota, and on the 26th and 27th for Wyoming and most of Montana.

Stock warnings.—Warnings for the benefit of livestock were disseminated on the 19th for Nebraska and western Kansas. The ensuing conditions were as forecast.

Change in forecast district.—The States of Montana and Wyoming were transferred from the Chicago to the Denver forecast district, effective January 1, 1926. On and after that date all weather forecasts and warnings for these States will be issued from Denver, Colo.—*C. A. Donnel.*

NEW ORLEANS FORECAST DISTRICT

Anticyclonic conditions were dominant in this district during the greater part of the month, with average temperature considerably below normal and comparatively dry weather, except for precipitation above normal on the west coast of Texas. A cold rain, mixed occasionally with small amounts of sleet and snow, fell on the Texas coast during the last five days, with temperatures of freezing or lower for a considerable part of this period.

Small-craft warnings were displayed on the Texas coast on the 3d and on the Louisiana coast and east coast of Texas on the 4th, because of an interior disturbance. While the disturbance was passing eastward a wind velocity of 44 miles an hour occurred at Galveston, Tex., in the early morning of the 4th. Small craft warnings were displayed also on the 13th and 14th on the Texas coast, being changed to northwest storm warnings at 8:30 p. m. of the 14th. These warnings were justified.

The advance of the anticyclonic area of the 13th–16th was attended by colder weather, for which cold-wave warnings were issued for the northern portion of the district on the 13th and extended over most interior sections of the district on the 14th. As the LOW in advance of the HIGH decreased greatly in intensity and the HIGH settled with crest over the Plateau States, the fall in temperatures was not sufficient to verify cold wave warnings in much of the area covered by the warnings.

A cold wave on the 20th–21st occurred in the northern portion of the district, following an eastward moving trough of low pressure. The high pressure following this LOW moved slowly over the Gulf States, prolonging the period of cold weather until the 24th.

Livestock warnings were issued for Oklahoma and north portion of west Texas on the morning of Saturday, the 26th, with a prediction of much colder weather Sunday and Sunday night; and much colder Sunday night was forecast for Arkansas. The 8 p. m. map of the 26th revealed such rapid southward progress of the area of high pressure that warnings for a severe cold wave were issued for the entire district, and these warnings were repeated the next morning for most sections of the district, with more specific temperature forecasts. Warnings for stockmen were included in the cold-wave warnings. The cold wave advanced to the coast as forecast, with the lowest temperatures of the month on the 28th, and was attended by strong northerly winds, for which northwest storm warnings were issued for the Texas coast at 8:30 p. m. of the 26th and small-craft warnings were displayed on the Louisiana coast on the 27th.

Warnings for frost or freezing temperature were issued for the more southern portions of the district on the 4th, 5th, 15th, 16th, 17th, 21st, 22d, 23d, 25th, and 28th. Conditions occurred mostly as forecast.

Fire-weather warnings were sent to addresses in Arkansas, Oklahoma, and Texas on the 3d. Norther warnings for Tampico, Mexico, were issued to interests concerned on the 15th and 27th.—*R. A. Dyke.*

DENVER FORECAST DISTRICT

Temperatures averaged above normal except in New Mexico, where it was unusually cold, especially in the extreme south portion. Precipitation was considerably above normal in eastern Colorado and excessive in the extreme north-central portion; in all other parts of the district it was deficient. The notable meteorological feature of the month was that practically all of the energetic disturbances that affected the district appeared in or crossed eastern Colorado and there were none of the usual winter developments of LOWS in the Plateau region. Warnings of moderate cold waves were issued for southeastern New Mexico on the mornings of the 14th and 20th, of a severe cold wave for eastern Colorado and a moderate cold wave for eastern New Mexico on the evening of the 26th, the latter being repeated as a livestock warning for eastern New Mexico on the morning of the 27th. All of these warnings were fully verified as to temperature, but the snow forecast on the 27th for eastern New Mexico did not occur, so that the livestock warning was not justified. Warnings of frost or freezing temperature for south-central and southeastern Arizona were issued on 18 days, the greater part of them being verified.—*E. B. Gittings, jr.*

SAN FRANCISCO FORECAST DISTRICT

During the month of December, 1925, the weather in this district was dominated by a series of high-pressure areas which moved in from the Pacific Ocean and became more or less stagnant over the Plateau region. This condition caused storms from the North Pacific Ocean to move eastward at an unusually high latitude for this season of the year. When these areas of high pressure moved eastward or disintegrated, the storms swung farther south and gave precipitation in this district.

There were three wet periods during the month; on the 1st and 2d and from the 18th to the 23d rain or snow occurred generally throughout the district, and from the 10th to the 13th, in the North Pacific States and Idaho. On the 28th local rain occurred in southern California. Tule fog prevailed in the Sacramento and San Joaquin Valleys during the third decade.

Frosts occurred quite often in northern California but caused no material damage.

Storm warnings were ordered along the coast 8 times, and, while verifying velocities at coast stations did not occur on all occasions, vessel reports at sea indicated the warnings were justified.—*G. H. Willson.*

RIVERS AND FLOODS

By H. C. FRANKENFIELD

As will be noted in the table following this report, no floods of consequence occurred during the month.

Near the end of the month the Mississippi River was frozen as far down as the mouth of the Missouri River; at St. Louis heavy ice began running on the night of the 22d and by the morning of the 23d the river was full of thick cakes, causing a suspension of navigation. On this date also navigation was temporarily suspended in the lower Missouri for the same reason. Forecasts of these conditions were issued by the St. Louis office of the Weather Bureau in ample time to permit the safeguarding of boats, barges, and other floating property on both the Missouri and Mississippi in that district. Floating ice had been observed at New Madrid, Mo., by the end of the month, but none was reported at more southerly stations.

River	Station	Flood stage	Above flood stages—dates		Crest	
			From—	To—	Stage	Date
Mississippi drainage:		*Feet*			*Feet*	
Petit Jean	Danville, Ark.	20	15	18	22.1	Dec. 16
Black	Corning, Ark.	9	(1)	17	13.1	Nov. 15
	Black Rock, Ark.	14	5	6	14.0	Dec. 5–6
Cache	Patterson, Ark.	9	8	9	9.0	Dec. 8–9
Pacific drainage:						
Gila	Kelvin, Ariz.	5	3	3	5.5	Dec. 3

[1] Continued from last month.

MEAN LAKE LEVELS DURING DECEMBER, 1925

By UNITED STATES LAKE SURVEY

[Detroit, Mich., January 6, 1926]

The following data are reported in the "Notice to Mariners" of the above date:

Data	Lakes[1]			
	Superior	Michigan and Huron	Erie	Ontario
Mean level during December, 1925:	*Feet.*	*Feet*	*Feet*	*Feet*
Above mean sea level at New York	600.87	577.54	570.46	244.55
Above or below—				
Mean stage of November, 1925	−0.24	−0.14	−0.01	+0.24
Mean stage of December, 1924	−0.55	−0.94	−0.32	−0.03
Average stage for December last 10 years	−1.33	−2.26	−1.17	−0.67
Highest recorded December stage	−2.26	−5.04	−3.07	−3.06
Lowest recorded December stage	−0.33	−0.94	−0.40	+1.12
Average departure (since 1860) of December levels from November levels	−0.26	−0.22	−0.09	−0.10

[1] Lake St. Clair's level: In December, 1925, 572.83 feet.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, DECEMBER, 1925

By J. B. KINCER

General summary.—The generally mild weather, light precipitation, and absence of severe storms during the first half of December made favorable weather for agricultural interests during that period in nearly all sections of the country. In the South, seasonal outdoor operations made good progress, except for some slight interruptions by rainfall, and winter cereals and truck crops advanced satisfactorily. The moist, warm weather in Florida, however, was rather unfavorable for handling citrus fruit. Over the Great Plains area nearly ideal weather prevailed for outside work, and the absence of material snow cover permitted livestock to range freely, even in the more northern districts, thus saving much feed. More rain was needed in the Pacific area.

The latter half of the month was less favorable for agricultural interests. In the Southeastern States the third week was cloudy and rainy, which delayed trucking operations in the more southern districts, though some progress was made on higher ground of Florida. During the same period frost over the west Gulf area extended to extreme southern Texas and did some damage to tender truck crops. Near the close of the month a severe cold wave overspread all central and eastern portions of the country and growing winter truck crops sustained considerable injury in Southeastern States.

Small grains.—Late-sown winter grains made slow growth during much of the month in the interior valley States, but wheat, while small, maintained in most sections rather satisfactory condition. More moisture was needed in parts of the Southwest, especially in the western portions of Texas and Oklahoma. The northern portions of the belt had a fairly good snow cover during the cold weather the latter part of the month, but some harm was reported by freezing locally in the Ohio Valley. Rain was needed in California, but conditions were more favorable in the Pacific Northwest where the melting snow penetrated the soil and improved its condition.

Corn and cotton.—The open weather the first half of the month in the interior valleys favored late gathering of corn and by the middle this work was nearly done, or actually completed in most sections. There was much complaint, however, of high moisture content, particularly in the upper Mississippi Valley. Picking of the remnants of the cotton crop in the northwestern portion of the belt was favored, and by the middle of the month harvest was nearly completed in Oklahoma, and also in Arkansas except in some eastern counties.

Miscellaneous crops and livestock.—Except where the soil was too wet locally in some southeastern districts, truck crops did well in the Southern States until the cold weather near the close of the month, although there were some unfavorable frosts in Texas during the third week. The cold wave near the close did considerable damage to cabbage, lettuce, and other hardy truck in south Atlantic and east Gulf districts, except in the southern portion of Florida, where there was no material harm.

Truck did well in California, with planting active in the Imperial Valley. Cane harvest was practically completed in Louisiana, with yield generally unsatisfactory. The month was mostly favorable for livestock interests in the great western grazing districts, although snow-covered range in parts of the central Rocky Mountain area necessitated heavy feeding. Snowfall continued markedly deficient in the far western mountains, with little or none stored in the high Sierras of California at the close of the month; more moisture was badly needed in all parts of that State.

CLIMATOLOGICAL TABLES[1]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, December, 1925

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	45.1	−1.6	3 stations	81	[1] 13	Valley Head	3	[1] 28	3.64	−1.47	Coffee Springs	7.26	Riverton	1.79
Alaska (*November*)	27.1	+5.2	Wrangell	56	7	Allakaket	−42	25	8.37	+0.90	Latouche	28.52	White Mountain	0.02
Arizona	44.6	+0.6	Gila Bend	85	13	Bright Angel Ranger Station.	−12	21	0.63	−0.68	Mount Graham Mill	3.55	2 stations	0.00
Arkansas	40.2	−1.9	Ozark	80	4	Dodd City	−6	28	1.71	−2.38	El Dorado	5.10	Rogers	0.13
California	48.6	+2.5	Blue Canyon	91	6	Sierraville	−2	20	1.85	−1.86	Crescent City	6.75	Greenland Ranch	0.00
Colorado	26.7	+2.0	Las Animas	72	9	Dillon	−31	15	0.89	−0.28	Savage Basin	3.41	Haswell	T.
Florida	58.3	−1.4	Sanford	88	[1] 14	Bluff Springs	15	28	5.77	+2.88	Madison	11.92	Davie	0.93
Georgia	46.2	−0.9	Blakely	83	14	Blue Ridge	0	28	3.92	−0.31	Brunswick	9.06	Woodbury	2.20
Hawaii	71.0	+1.4	2 stations	90	22	2 stations	46	[1] 27	4.46	−6.29	Olokele (Mauka)	18.50	Puu Kea	0.00
Idaho	31.1	+5.5	Lapwai	64	23	Stanley	−18	29	1.77	−0.14	Pete King Ranger Station.	5.58	Lifton	0.11
Illinois	27.6	−2.6	Sparta	72	12	Mount Carroll	−17	20	1.34	−0.80	2 stations	2.44	2 stations	0.52
Indiana	28.6	−3.3	Vevay	70	[1] 4	2 stations	−12	27	1.09	−1.65	Madison	2.34	Frankfort	0.24
Iowa	21.0	−3.1	Clarinda	64	9	Waverly	−25	29	1.30	+0.16	Fairfield	3.52	2 stations	0.30
Kansas	33.2	+1.6	Alden	72	12	Atwood	−8	28	0.27	−0.66	Wellington	1.44	25 stations	T.
Kentucky	34.8	−2.8	Sergent	70	4	Williamstown	−5	27	0.90	−3.18	2 stations	1.94	Ravenna	0.25
Louisiana	49.0	−2.8	Donaldsonville	83	14	Robeline	11	33	3.55	−1.63	Reserve	6.35	Minden	0.27
Maryland-Delaware	35.4	+0.4	3 stations	64	[1] 5	Frostburg, Md	−7	28	1.90	1.47	Millsboro, Del	4.22	2 stations	0.90
Michigan	23.7	−1.2	Allegan	58	5	3 stations	−25	[1] 26	1.63	−0.45	Mancelona	3.50	Mackinac Island	0.51
Minnesota	14.0	−0.9	3 stations	51	[1] 2	Pine River Dam	−27	29	0.56	−0.18	Winona	2.18	Fosston	0.00
Mississippi	45.5	−2.4	Columbia	83	14	Holly Springs	3	26	3.11	−2.38	Port Gibson	5.59	Jackson	1.55
Missouri	31.6	−2.3	Hollister	80	1	Unionville	−10	27	1.45	−0.58	Fulton	3.69	Oregon	0.45
Montana	20.0	+7.6	Harlowton	74	11	Garland	−46	27	0.93	+0.06	Heron	5.08	Sunset Orchard	0.04
Nebraska	26.7	+0.9	Alma	71	12	Kimball	−20	28	0.96	+0.22	Hull	3.27	Franklin	0.10
Nevada	34.5	+3.2	2 stations	72	[1] 25	Montello	−2	31	0.53	−0.42	Tuscarora	1.64	3 stations	0.00
New England	26.1	−0.4	2 stations	61	[1] 6	2 stations	−25	[1] 27	3.00	−0.36	Kingston, R. I	7.06	Bethlehem, N. H	0.59
New Jersey	34.0	+1.0	2 stations	61	6	Culvers Lake	−5	27	2.84	−1.13	Lakewood	4.58	Moorestown	1.00
New Mexico	32.0	−1.1	2 stations	78	[1] 12	Senorito (near)	−15	4	0.48	−0.28	Pinos Altos (near)	2.36	6 stations	0.00
New York	27.3	+1.1	2 stations	60	[1] 5	North Lake	−34	27	2.44	−0.57	Palermo	5.73	Chazy	0.49
North Carolina	40.9	−1.4	New Holland	75	5	Parker	−17	28	2.72	−1.22	Edenton	7.45	Cullowhee	0.77
North Dakota	16.5	+3.5	Steele	67	10	Marmarth	−38	26	0.28	−0.36	Linton	1.20	4 stations	0.00
Ohio	29.0	−2.2	2 stations	64	[1] 4	3 stations	−11	[1] 29	0.82	−2.08	Cleveland (No. 2)	2.20	Wapakoneta	0.35
Oklahoma	38.9	0.0	2 stations	76	3	2 stations	−1	[1] 28	0.36	−1.26	Bartlesville	1.18	4 stations	0.00
Oregon	38.3	+3.8	Big Eddy	69	5	Blitzen	0	14	3.32	−0.98	Classic Lake	16.25	Paisley	0.12
Pennsylvania	30.7	−0.2	Derry	62	4	2 stations	−15	[1] 28	1.72	−1.46	Snow Hill	3.93	Beaver Dam	0.69
Porto Rico	74.9	+0.4	Juncos	94	18	Aibonito	47	28	0.95	−3.67	Jajome Alto	4.48	5 stations	0.00
South Carolina	44.4	−2.2	2 stations	77	4	Liberty	1	27	3.26	−0.21	Garnett	3.78	Spartanburg	1.37
South Dakota	22.1	+2.2	Mud Butte	72	2	Camp Crook	−43	27	0.50	−0.12	Hardy Ranger Station.	1.53	Milbank	T.
Tennessee	38.2	−1.8	2 stations	71	[1] 4	Rugby	−5	28	1.72	−2.83	Charleston	3.71	2 stations	0.60
Texas	45.4	−4.4	Ricardo	94	2	Romero	4	28	1.17	−0.99	Mission	6.61	21 stations	0.00
Utah	31.4	−5.1	Saint George	68	5	East Portal	−8	21	0.67	−0.59	Silver Lake	2.29	2 stations	0.00
Virginia	37.5	0.0	Norfolk	71	5	Burkes Garden	−10	28	2.69	−0.54	Runnymede	6.54	Radford	0.74
Washington	39.0	+5.9	Fort Simcoe	67	12	Snyder's Ranch	6	28	5.12	−0.22	Quinault	27.66	Quincy	0.19
West Virginia	32.5	−1.0	Smithfield	75	5	2 stations	−8	[1] 28	1.20	−2.21	White Sulphur Springs.	3.42	Spencer	0.38
Wisconsin	16.4	−3.9	Marinette	49	5	Hatfield	−32	29	1.49	+0.23	Lancaster	2.53	Coddington	0.64
Wyoming	25.5	+4.7	Eden	70	2	Saratoga	−26	30	0.92	+0.11	Yoder	4.10	2 stations	T.

[1] For description of tables and charts, see REVIEW, January, 1925, p. 42.

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, December, 1925*

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
New England							29.6	+0.2										73	2.77	−0.6											5.9		
Eastport	76	67	85	29.69	29.78	−.20	24.6	−1.7	51	6	31	−2	27	18	30	23	20	80	2.07	−1.9	11	10,833	w.	41	ne.	4	6	11	14	6.9	10.4	5.5
Greenville, Me	1,070	6		28.60	29.81		17.1		47	6	24	−12	27	10	28				2.57		15	7,654	nw.				11	4	16		17.0	
Portland, Me	103	82	117	29.72	29.85	−.18	27.6	0.0	51	6	34	−4	27	21	25	24	18	69	3.51	−0.2	13	7,580	w.	34	nw.	15	16	5	10	5.0	6.3	3.0
Concord	289	70	79	29.51	29.64	−.22	27.3	+0.5	55	6	34	−7	27	21	27				2.60	−0.8	11	5,528	nw.	33	nw.	23	12	7	12	5.7	6.6	2.0
Burlington	403	11	48	29.42	29.58	−.17	23.8	−0.6	48	4	30	−10	27	18	24				1.20	−0.5	16	9,005	nw.	44	nw.	9	3	4	24	8.5	4.8	0.9
Northfield	876	12	60	28.89	29.87	−.18	21.0	+0.6	50	6	29	−17	30	14	32	19	16	83	1.27	−1.4	17	5,496	s.	38	sw.	13	3	7	21	8.1	11.9	3.4
Boston	125	115	188	29.71	29.85	−.20	33.6	+1.1	59	6	40	4	27	28	22	30	23	67	5.20	+1.8	11	9,158	w.	37	w.	9	12	9	10	5.4	0.5	T.
Nantucket	12	14	90	29.83	29.84	−.21	34.8	−1.0	55	5	40	9	27	30	23	32	28	77	2.73	−0.9	12	15,036	w.	48	e.	3	8	11	12	5.9	3.4	0.0
Block Island	26	11	46	29.83	29.86	−.20	35.2	−0.8	56	6	40	9	27	30	23	32	27	72	2.19	−1.6	12	20,456	nw.	60	nw.	23	10	10	11	5.3	0.6	0.0
Providence	160	215	251	29.70	29.88	−.18	32.4	+0.8	57	6	38	4	27	26	23	29	23	68	3.28	−0.6	14	11,955	nw.	58	nw.	23	11	9	11	5.2	1.5	0.1
Hartford	159	122	140	29.72	29.91	−.16	32.2	+2.4	58	6	38	3	27	26	22				2.99	−0.6	14		nw.				13	8	10	4.9	3.0	0.0
New Haven	106	74	153	29.78	29.90	−.17	33.0	+0.5	57	6	39	6	27	27	24	29	24	72	3.44	−0.2	11	8,805	w.	40	ne.	3	13	10	8	4.5	2.5	T.
Middle Atlantic States							35.4	−0.1										71	2.31	−0.9										6.2		
Albany	97	102	115	29.79	29.90	−.18	30.2	+1.7	54	4	36	−2	27	24	26	27	24	80	1.52	−1.0	12	5,443	nw.	26	nw.	9	6	6	19	7.0	2.3	0.0
Binghamton	871	10	84	28.96	29.92	−.17	29.7	+1.5	54	4	35	−4	27	24	21				2.16	−0.3	18	6,006	w.	26	nw.	13	1	5	25	8.9	2.5	0.5
New York	314	414	454	29.56	29.92	−.17	34.5	−0.5	57	6	41	7	27	28	22	30	24	68	3.33	−0.1	12	17,079	nw.	65	nw.	27	8	12	11	6.2	0.9	0.0
Harrisburg	374	94	104	29.56	29.93	−.14	33.6	+0.9	54	5	39	10	27	28	20	30	23	66	2.01	−0.6	10	6,558	nw.	30	nw.	23	8	8	15	6.4	T.	0.0
Philadelphia	114	123	190	29.82	29.95	−.16	36.6	+0.3	61	5	43	13	27	31	20	33	26	67	0.96	−2.1	8	7,649	nw.	35	ne.	3	13	5	13	5.7	0.1	0.0
Reading	325	81	98	29.60	29.96		34.2		55	5	40	11	27	29	21	31	27	76	1.54	−1.8	11	6,818	nw.	27	nw.	27	7	10	14	6.6	0.3	0.0
Scranton	805	111	119	29.05	29.94	−.16	31.0	+0.3	52	5	37	0	27	25	24	28	25	81	1.47	−1.1	13	6,100	sw.	28	sw.	9	2	5	24	8.5	1.9	T.
Atlantic City	52	37	172	29.88	29.94	−.16	36.4	0.0	56	5	42	13	27	31	22	33	28	72	3.42	−0.3	11	15,228	w.	70	ne.	2	12	5	14	5.2	T.	0.0
Cape May	17	13	49	29.96	29.98	−.13	37.8	−0.2	54	3	43	15	27	33	20	35	30	74	3.02	−0.8	11	8,436	nw.	40	ne.	2	9	4	18	6.5	T.	0.0
Sandy Hook	22	10	55	29.89	29.91		35.0		55	5	40	11	27	30	21	31	26	70	2.40		11	16,651	w.	58	nw.	22	9	10	12	5.7	0.2	0.0
Trenton	190	159	183	29.72	29.93		34.4		60	5	41	11	27	28	21	30	24	68	1.65	−1.5	9	11,167	nw.	48	ne.	3	8	10	13	6.1	0.4	0.0
Baltimore	123	100	113	29.83	29.97	−.16	37.3	+0.1	59	8	43	13	27	31	19	33	27	67	1.54	−1.5	10	4,979	sw.	31	ne.	2	10	7	14	5.7	0.2	0.0
Washington	112	62	85	29.85	29.96	−.15	37.0	+0.4	59	8	43	13	27	31	25	32	25	65	1.07	−2.1	8	6,302	nw.	33	ne.	2	9	7	15	6.2	T.	0.0
Cape Henry	18	8	54	29.94	29.96		40.9		63	12	46	14	28	35	21	37	33	76	3.82	+0.4	12	10,913	sw.	60	ne.	2	9	6	16	6.2	0.0	0.0
Lynchburg	681	153	188	29.24	30.00	−.14	39.4	−0.1	64	5	47	8	28	32	29	33	25	60	2.36	−0.4	8	7,209	w.	37	ne.	2	13	7	11	4.8	0.0	0.0
Norfolk	91	170	205	29.88	29.98	−.15	40.8	−2.3	71	5	47	11	28	35	22	36	31	70	4.20	+0.7	10	10,441	w.	56	ne.	2	11	3	17	5.9	0.0	0.0
Richmond	144	11	52	29.84	30.00	−.14	38.6	−1.2	62	5	46	9	28	31	23	34	29	72	3.89	+0.9	9	6,812	sw.	33	ne.	2	14	6	11	4.9	T.	0.0
Wytheville	2,304	49	55	27.58	30.04	−.11	33.4	−1.9	63	4	40	−6	28	26	28	29	25	73	0.86	−2.9	9	7,143	w.	32	sw.	9	11	5	15	5.6	0.7	0.0
South Atlantic States							45.9	−1.4										74	3.60	+0.2										5.7		
Asheville	2,253	70	84	27.63	30.06	−.10	36.6	−1.2	62	13	45	0	28	28	30	32	27	72	1.10	−2.0	8	7,221	nw.	30	n.	23	13	6	12	5.2	T.	0.0
Charlotte	779	55	62	29.18	30.03	−.13	42.2	−0.8	68	4	50	10	28	34	27	37	33	74	2.41	−1.4	10	4,282	sw.	26	n.	2	13	3	15	5.4	0.0	0.0
Hatteras	11	11	50	29.97	29.98	−.15	47.9	−2.2	72	5	54	18	28	42	24	43	40	80	3.80	−1.3	11	12,858	w.	62	w.	22	9	6	16	6.0	0.0	0.0
Raleigh	376	103	110	29.60	30.02	−.13	41.9	−1.1	66	12	50	9	28	34	24	38	35	81	2.70	−0.5	11	6,699	w.	44	nw.	22	10	5	16	6.0	0.0	0.0
Wilmington	78	81	91	29.94	30.03	−.12	46.8	−2.3	70	5	55	13	28	39	28	41	37	76	4.44	+1.3	9	5,114	w.	30	w.	22	10	6	15	6.0	0.0	0.0
Charleston	48	11	92	30.00	30.04	−.11	49.2	−2.5	72	13	57	18	28	42	24	44	40	75	4.00	+0.8	12	7,685	w.	43	n.	1	9	6	16	5.9	0.0	0.0
Columbia, S. C	351	41	57	29.66	30.05	−.11	45.7	−1.5	73	13	54	12	28	37	29	39	34	69	2.70	−0.2	8	5,073	sw.	32	sw.	22	12	4	15	5.6	0.0	0.0
Due West	711	10	55	29.28	30.08		42.9		69	4	52	9	28	34	28				2.78		8	6,998	sw.	44	w.	22	13	5	13	5.1	0.0	0.0
Greenville, S. C	1,039	113	122	28.90	30.02		43.3	+1.1	67	9	52	9	28	35	27	37	31	69	1.81		9	6,574	sw.	46	w.	22	15	5	11	4.7	0.0	0.0
Augusta	182	62	77	29.86	30.06	−.10	46.9	−1.2	73	4	56	15	28	38	29	42	38	77	2.48	−1.0	9	4,296	w.	32	w.	22	10	6	15	5.9	0.0	0.0
Savannah	65	150	194	29.99	30.06	−.09	50.4	−2.0	74	4	58	21	28	42	26	44	39	73	5.43	+2.3	12	9,715	w.	51	nw.	1	10	5	16	5.9	0.0	0.0
Jacksonville	43	209	245	30.02	30.06	−.06	54.1	−2.2	80	15	62	24	28	46	25	48	43	72	6.98	+4.0	11	9,917	w.	52	n.	1	7	10	14	6.3	0.0	0.0
Florida Peninsula							66.5	+0.1										80	2.80	+0.6										5.4		
Key West	22	10	64	30.02	30.04	−.04	71.2	+0.9	83	17	76	58	29	66	18	66	64	83	1.72	−0.1	7	7,523	ne.	52	nw.	1	13	12	6	4.4	0.0	0.0
Miami	25	71	79	30.04	30.07		68.4	+0.4	83	9	75	46	27	61	23	62	60	79	2.68	+0.7	6	4,370	nw.	26	nw.	1	11	6	14	5.7	0.0	0.0
Tampa	35	79	87	30.06	30.07	−.05	60.0	−1.1	79	16	68	33	29	52	30	55	51	77	3.10	+1.1	12	4,658	ne.	52	ne.	1	6	11	14	6.6	0.0	0.0
Titusville	44	5		30.01	30.06		59.8		87	15	70	34	29	60	31				8.86		8		w.				13	6	12	5.1	0.0	0.0
East Gulf States							47.0	−2.5										70	3.75	−0.8										5.9		
Atlanta	1,173	190	216	28.81	30.08	−.08	42.4	−2.3	68	4	50	5	28	34	28	37	32	71	2.46	−2.1	7	9,323	nw.	40	nw.	22	13	3	15	5.5	T.	0.0
Macon	370	78	87	29.68	30.08	−.08	46.4	−1.1	73	4	56	11	28	37	30	40	33	67	2.37	−2.0	7	4,575	nw.	25	s.	4	9	8	14	5.9	0.0	0.0
Thomasville	273	49	58	29.79	30.09	−.06	51.2	−1.3	76	4	60	18	28	42	28	44	39	73	6.93	+3.2	12	3,615	sw.	29	sw.	19	5	9	17	6.8	0.0	0.0
Apalachicola	36	42	49	30.05	30.09		53.2		74	15	61	24	28	46	24	48	44	78	5.94		14	6,623	n.	32	sw.	19	9	8	14	6.2	0.0	0.0
Pensacola	56	149	185	30.04	30.11	−.04	50.9	−3.1	72	15	58	18	28	43	23	46	41	72	2.03	−2.1	10	9,642	n.	48	nw.	19	6	9	16	6.5	0.0	0.0
Anniston	741	9	57	29.31	30.12	−.04	41.9	−2.3	71	4	52	6	28	31	35				5.09	+0.6	9	3,995	nw.	24	s.	4	13	5	13	5.5	T.	0.0
Birmingham	700	11	48	29.35	30.13	−.03	43.1	−3.3	70	12	53	7	28	33	36	37	31	68	4.14	−0.5	9	5,018	n.	34	s.	4	15	6	10	4.8	T.	0.0
Mobile	57	125	161	30.05	30.11	−.04	50.0	−2.2	76	14	58	18	28	41	26	44	38	69	6.09	+1.5	11	7,672	n.	37	e.	19	4	18	9	6.0	0.0	0.0
Montgomery	223	100	112	29.87	30.13	−.03	47.0	−2.4	78	14	56	12	28	38	30	41	34	65	2.05	−2.4	7	5,080	n.	28	nw.	22	12	7	12	5.5	0.0	0.0
Corinth	469	6					41.0		70	13	51	6	28	31	39				2.15		6						6	16	9		0.2	
Meridian	375	85	93	29.72	30.13	−.03	45.2	−2.5	75	14	55	10	28	35	32	39	34	72	2.38	−2.8	7	4,022	n.	25	w.	4	10	12	9	5.4	0.0	0.0
Vicksburg	247	65	73	29.87	30.16	+.01	46.6	−3.4	75	3	56	13	28	38	30	40	33	64	3.71	−1.3	7	5,175	ne.	34	w.	4	8	6	17	6.6	T.	0.0
New Orleans	53	76	84	30.07	30.13	.00	52.3	−3.3	80	14	60	22	28	44	31	46	41	72	3.58	−0.9	10	5,216	ne.	22	ne.	27	9	13	9	6.0	0.0	0.0
West Gulf States							46.4	−4.0										72	1.61	−1.3										5.6		
Shreveport	249	77	93	29.88	30.16	+.03	46.0	−3.1	75	3	55	17	28	37	29	40	34	69	2.87	−1.5	6	5,229	nw.	33	w.	4	13	7	11	5.0	0.0	0.0
Bentonville	1,308	11	44				35.8	−1.7	65	12	45	1	27	26	31				0.38		6	4,492	sw.	24	s.	3	16	7	8		0.9	0.0
Fort Smith	457	79	94	29.62	30.12	−.01	39.0	−3.1	70	12	48	8	28	30	35	34	29	73	2.00	−0.9	7	6,470	e.	36	w.	4	14	5	12	4.9	0.3	0.0
Little Rock	357	136	144	29.73	30.13	−.01	40.9	−3.3	68	3	50	8	28	32	29	35	28	64	0.96	−3.3	4	6,795	s.	39	w.	4	15	4	12	4.7	0.1	0.0
Brownsville	57	53	61	30.06	30.12		53.7	−7.5	79	3	61	26	28	47	32	49	46	84	3.72		14	7,125	n.	35	n.	4	7	2	22	7.5	T.	0.0
Corpus Christi	20	11	73	30.13	30.15	+.03	51.4	−6.6	85	3	59	24	28	44	28	47	44	81	3.00	+1.7	11	8,699	n.	38	n.	27	9	5	17	6.8	0.0	0.0
Dallas	512	109	117	29.60	30.16		45.3		80	3	56	15	28	35	35				0.03		1	6,434	nw.	40	nw.	4	16	9	6	3.9	T.	0.0
Fort Worth	670	106	114	29.41	30.14	+.02	46.0	−1.5	80	3	56	16	28	36	25	38	29	58	0.04	−1.8	1	7,738	nw.	46	nw.	4	14	9	8	4.6	0.1	0.0
Galveston	54	106	114	30.09	30.15	+.03	51.0	−5.4	72	3	57	26	28	45	23	47	43	80	2.63	−1.1	12	8,646	n.	44	nw.	4	11	8	12	5.7	T.	0.0
Groesbeck	461	11	50	29.66	30.13		45.2		73	11	55	17	28	35	36				0.54		4	8,315	n.	42	w.	4	13	8	10	5.0	0.0	0.0
Houston	138	111	121	30.00	30.15		50.1	−4.4	77	3	58	26	28	42	27				3.20		12	5,525	n.	23	n.	27	9	7	15	6.3	0.4	0.0
Palestine	510	64	72	29.61	30.15	+.03	45.7	−4.2	73	12	54	17	28	37	32	39	33	64	0.87	−2.8	5	5,593	n.	30	ne.	27	13	6	12	5.3	0.0	0.0
Port Arthur	34	58	66	30.09	30.11		49.6		76	12	57	24	28	42	25	44	40	78	1.83		13	7,032	n.	38	nw.	4	7	7	17	6.5	T.	0.0
San Antonio	693	119	132	29.42	30.16	+.05	49.7	−4.0	76	3	59	19	28	40	31	43	37	66	1.29	−0.3	8	5,626	n.	45	nw.	4	8	9	14	6.2	1.0	0.0
Taylor	583	55	63	29.56	30.18	+.07	47.2	−3.4	78	11	57	17	28	38	38				0.82	−1.8	6	6,817	s.	34	nw.	4	7	10	14	6.5	T.	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, December, 1925*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest Daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*		*°F.*	*°F.*		*°F.*	*°F.*	*°F.*	*°F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							33.7	−2.9										74	1.23	−2.2											6.5		
Chattanooga	762	189	213	29.26	30.10	−.06	40.6	−2.7	65	3	49	4	28	32	28	35	29	66	3.56	−0.8	9	6,273	sw.	33	sw.	4	11	7	13	5.5	0.2	0.0
Knoxville	995	102	111	29.00	30.08	−.08	39.2	−1.1	67	4	47	4	28	31	23	34	29	71	1.83	−2.3	7	5,373	sw.	31	sw.	5	12	8	11	5.1	0.5	0.0
Memphis	399	76	97	29.69	30.13	−.02	41.0	−2.6	69	3	48	8	28	34	26	36	31	72	0.98	−3.4	4	6,630	n.	48	sw.	4	11	10	10	5.1	0.3	0.0
Nashville	546	168	191	29.53	30.13	−.02	38.2	−2.8	65	11	46	4	28	30	26	33	28	69	1.10	−2.7	5	6,783	nw.	34	sw.	5	12	5	14	5.4	0.5	0.0
Lexington	989	193	230	29.02	30.10	−.04	31.8	−4.0	62	4	39	−3	27	25	23				0.80	−2.5	8	10,734	sw.	38	sw.	6	10	5	16	6.6	0.7	0.0
Louisville	525	188	234	29.50	30.11	−.03	33.2	−4.4	61	11	40	−2	27	26	24	29	24	72	1.14	−2.6	5	8,681	s.	37	sw.	4	8	8	15	6.1	2.0	0.0
Evansville	431	139	175	29.62	30.11	−.02	33.7	−3.4	61	11	41	0	27	26	24	30	25	74	1.06	−2.8	4	8,717	sw.	44	sw.	4	10	13	8	5.3	1.2	0.0
Indianapolis	822	194	230	29.15	30.07	−.05	28.5	−3.7	58	4	36	−7	27	22	24	25	21	78	1.09	−2.0	7	8,969	nw.	38	sw.	4	4	13	14	6.6	3.0	T.
Royal Center	736	11	55	29.22	30.06	.....	24.3	.....	52	4	32	−11	27	17	28				0.80	.....	8	8,250	w.	32	sw.	5	4	8	19	7.5	3.6	0.2
Terre Haute	575	96	129	29.43	30.08	.....	29.2	.....	59	4	36	−4	27	22	27	26	22	79	1.21	.....	6	7,542	nw.	34	s.	4	4	11	16	6.7	2.7	0.1
Cincinnati	627	11	51	29.37	30.07	−.06	30.7	−2.7	60	4	38	−4	27	23	29	.....	27	85	0.67	−2.3	6	6,658	sw.	28	sw.	5	10	7	14	6.0	1.0	T.
Columbus	822	179	222	29.14	30.04	−.08	29.7	−2.7	59	4	37	−6	27	23	28	26	23	78	0.73	−2.0	8	8,323	w.	37	sw.	11	5	4	22	8.0	1.2	T.
Dayton	899	137	173	29.06	30.05	.....	29.6	−3.0	58	4	37	−4	27	22	28	26	22	74	0.72	−1.9	7	8,187	sw.	35	sw.	5	9	9	13	6.2	1.4	T.
Elkins	1,947	59	67	27.92	30.06	−.06	31.0	−1.7	63	4	39	−2	27	23	33	27	23	77	1.56	−1.9	13	5,338	w.	32	sw.	11	6	4	21	7.5	8.1	1.5
Parkersburg	637	77	82	29.39	30.06	−.06	33.4	−1.8	64	4	41	2	27	26	29	24	72	0.57	−2.2	5	5,146	sw.	36	nw.	12	4	6	21	7.8	0.6	T.
Pittsburgh	842	353	410	29.08	30.02	−.09	30.8	−3.4	58	4	37	0	27	25	24	28	23	73	1.40	−1.3	12	10,372	w.	43	sc.	5	2	10	19	8.0	2.9	1.0
Lower Lake Region							27.4	−1.7										79	1.98	−0.9										8.2		
Buffalo	767	247	280	29.07	29.93	−.18	27.2	−2.6	57	4	32	−7	27	22	22	26	23	81	2.31	−1.1	15	18,250	w	70	w.	12	1	5	25	8.6	18.7	4.2
Canton	448	10	61	29.36	29.86	.....	21.6	−1.1	54	5	28	−19	27	15	34	.....	.....	.....	2.53	−1.1	22	8,237	w.	45	w.	13	3	5	23	8.0	14.7	4.2
Oswego	335	76	91	.....	29.90	−.16	28.2	−0.8	53	4	34	−3	27	23	21	.....	.....	85	3.81	+0.2	24	11,131	nw.	44	nw.	9	0	3	28	.....	37.3	15.0
Rochester	523	86	102	29.34	29.92	−.14	28.4	−0.9	55	5	33	−5	27	24	21	26	22	76	1.73	−1.2	20	9,027	w.	38	w.	8	0	3	28	9.2	12.4	4.0
Syracuse	597	97	113	29.26	29.92	−.15	28.1	−0.2	58	5	33	−5	27	23	21	.....	.....	.....	3.18	+0.5	25	10,643	w.	45	w.	9	0	1	30	9.1	26.6	9.0
Erie	714	130	166	29.16	29.96	−.11	29.5	−2.4	57	5	34	5	27	25	24	27	23	77	1.20	−1.9	15	12,733	w.	48	s.	5	0	5	26	9.2	7.4	5.5
Cleveland	762	190	201	29.15	29.99	−.10	28.9	−2.3	55	4	34	3	29	24	26	26	23	80	1.45	−1.1	10	10,496	w.	46	w.	8	1	8	22	8.3	10.3	4.8
Sandusky	629	62	70	29.32	30.02	−.07	28.0	−3.2	55	5	34	0	27	22	25	.....	.....	.....	0.78	−1.6	10	7,291	sw.	26	nw.	12	2	11	18	7.6	5.3	3.1
Toledo	628	208	243	29.31	30.02	−.06	27.8	−2.6	53	5	34	0	27	21	28	25	20	74	1.17	−1.1	9	11,309	sw	46	sw.	8	6	7	18	7.2	8.7	2.4
Fort Wayne	856	113	124	29.07	30.02	.....	26.8	−0.5	54	4	34	−5	27	20	26	24	21	82	0.81	.....	9	7,694	sw.	33	sw.	5	6	7	18	7.1	2.6	1.2
Detroit	730	218	258	29.17	29.99	−.08	27.0	−2.3	50	5	33	−4	27	21	24	24	20	74	1.68	−0.7	12	8,674	w.	37	sw.	6	2	9	20	7.6	8.1	3.1
Upper Lake Region							22.1	−2.6										83	1.65	−0.6										7.7		
Alpena	609	13	92	29.23	29.92	−.10	23.6	−1.2	43	5	28	−9	27	19	31	22	20	84	1.50	−0.7	15	9,313	w.	44	nw.	8	0	5	26	8.8	6.3	3.2
Escanaba	612	54	60	29.27	29.96	−.07	20.2	−2.2	39	4	26	−4	27	14	25	19	16	83	1.32	−0.4	5	7,322	nw.	28	nw.	12	6	6	19	7.1	1.9	0.5
Grand Haven	632	54	89	29.27	29.96	−.07	27.4	−1.9	49	4	32	7	27	23	25	26	23	82	1.92	−0.6	16	9,830	w.	43	w.	8	2	4	25	8.9	19.1	6.8
Grand Rapids	707	70	87	29.20	30.00	−.05	26.7	−1.8	50	4	32	3	27	22	27	24	21	80	1.52	−1.0	15	4,974	nw.	22	nw.	12	1	6	24	8.7	17.1	5.0
Houghton	668	62	99	29.20	29.95	−.07	19.5	−2.3	43	2	24	−2	26	14	21	.....	.....	.....	2.04	−0.4	16	9,268	nw.	43	w.	13	0	8	23	9.0	19.5	8.5
Lansing	878	11	62	29.00	29.98	.....	24.4	−2.8	49	5	31	−9	26	18	28	23	21	80	1.15	−0.9	13	5,347	nw.	21	sw.	5	5	5	21	7.7	8.7	5.0
Ludington	637	60	66	29.25	29.97	.....	26.5	.....	47	5	31	7	26	22	22	24	21	82	1.54	.....	14	9,314	nw.	42	sw.	23	0	6	25	8.7	13.5	5.8
Marquette	734	77	111	29.11	29.94	−.08	21.0	−1.6	39	4	26	−1	26	16	22	19	16	84	2.80	+0.3	18	8,934	w.	33	nw.	8	1	5	25	8.8	16.3	8.0
Port Huron	638	70	120	29.25	29.97	−.09	25.7	−1.9	49	5	31	−7	27	20	24	24	21	84	1.12	−1.0	8	9,481	nw.	42	w.	12	5	8	18	7.2	9.7	4.8
Saginaw	641	.....	.....	29.26	29.97	.....	24.2	−3.0	48	5	30	−10	27	18	30	.....	.....	.....	1.13	.....	11	.....	w.	.....	.....	.....	4	5	22	.....	5.6	2.5
Sault Sainte Marie	614	11	52	29.19	29.91	−.09	20.2	−0.3	45	5	26	−17	26	15	32	20	18	86	2.21	−0.1	19	7,207	nw.	45	nw.	12	1	3	27	9.1	11.9	4.2
Chicago	823	140	310	29.12	30.04	−.04	25.4	−4.6	51	4	31	−8	27	19	25	23	17	70	1.21	−0.9	10	8,156	w.	28	s.	23	8	5	18	6.5	6.2	1.3
Green Bay	617	109	141	29.30	29.99	−.05	17.5	−4.8	42	4	24	−10	27	11	24	16	14	86	1.07	−0.7	6	8,123	sw.	34	nw.	12	7	7	17	6.7	4.7	2.2
Milwaukee	681	125	139	29.24	30.01	−.05	21.2	−4.9	45	4	28	−10	27	15	24	20	16	77	1.76	−0.2	8	7,661	w.	28	w.	8	10	6	15	6.3	10.0	2.8
Duluth	1,133	5	47	28.75	30.04	−.01	12.7	−3.2	38	2	20	−18	26	6	26	11	9	90	0.66	−0.6	6	11,056	nw.	57	nw.	4	15	4	12	4.7	3.7	1.5
North Dakota							16.3	+4.3										85	0.42	−0.2										6.3		
Moorhead	940	50	58	29.06	30.13	+.05	13.4	+1.9	42	2	21	−15	26	6	27	13	10	85	0.40	−0.3	6	6,674	n.	27	n.	3	7	5	19	6.8	3.8	0.9
Bismarck	1,674	8	57	28.32	30.20	+.12	19.6	+4.9	55	2	27	−12	26	12	34	16	14	83	0.35	−0.3	7	5,617	nw.	29	nw.	10	8	9	14	6.1	3.1	0.3
Devils Lake	1,478	11	44	28.48	30.14	+.08	13.8	+5.8	50	2	21	−17	26	7	32	12	10	87	0.49	+0.1	7	6,388	nw.	28	n.	3	7	9	15	6.3	3.9	0.8
Ellendale	1,457	10	56	28.51	30.14	.....	17.7	.....	48	11	26	−12	29	10	42	.....	.....	.....	0.24	.....	10	10,266	nw.	46	nw.	3	7	6	18	6.7	1.7	T.
Grand Forks	835	12	89	.....	.....	.....	11.6	.....	43	2	19	−16	26	4	30	11	.....	.....	0.26	.....	5	.....	nw.	34	nw.	8	1	6	17	6.4	2.3	1.0
Williston	1,878	41	48	28.09	30.16	+.10	18.5	+4.7	54	1	27	−22	28	10	28	16	14	85	0.45	−0.2	9	4,587	nw.	29	nw.	10	9	11	11	5.6	3.9	1.0
Upper Mississippi Valley							23.1	−3.7										82	1.41	−0.4										6.3		
Minneapolis	918	102	208	29.03	30.06	.....	16.6	−3.0	40	2	23	−13	26	11	25	.....	.....	.....	0.78	−0.2	6	8,947	nw.	43	n.	4	7	8	16	6.7	3.2	0.5
St. Paul	837	236	261	29.12	30.07	−.01	16.3	−2.7	39	8	22	−13	26	10	25	.....	.....	.....	0.61	−0.4	5	9,185	nw.	48	nw.	4	5	8	18	6.9	4.5	1.2
La Crosse	714	11	48	29.25	30.06	−.02	16.3	−6.0	42	2	24	−16	29	9	29	.....	.....	.....	2.23	+0.9	7	4,030	sc.	21	n.	4	8	8	15	6.3	16.3	9.0
Madison	974	70	78	28.95	30.06	−.02	17.6	−5.2	39	3	24	−14	27	11	23	16	14	87	1.79	0.0	8	6,812	nw.	27	sw.	8	9	6	16	6.5	11.4	5.8
Wausau	1,247	4	.....	28.80	30.00	.....	15.8	.....	39	8	22	−12	27	9	28	.....	.....	.....	1.05	.....	6	.....	w.	.....	.....	.....	3	5	21	7.6	5.9	1.6
Charles City	1,015	10	49	28.95	30.08	−.02	15.8	−4.6	40	8	24	−17	29	8	36	15	13	89	1.69	+0.4	8	5,088	nw.	27	nw.	4	9	7	15	6.1	10.2	5.6
Davenport	606	71	79	29.39	30.08	−.02	22.4	−4.7	46	3	30	−11	27	15	31	21	18	85	1.64	0.0	7	5,340	w.	24	nw.	26	7	6	18	7.0	9.3	1.0
Des Moines	861	84	97	29.14	30.09	−.02	25.0	−3.0	52	8	31	−9	27	15	36	21	17	78	1.67	+0.4	6	5,564	nw.	30	sw.	23	7	13	11	5.8	17.8	5.0
Dubuque	700	81	98	29.26	30.05	−.05	20.0	−4.7	43	3	27	−15	29	13	30	18	15	83	1.66	−0.1	6	4,986	nw.	31	n.	4	9	5	17	6.5	10.2	3.0
Keokuk	614	64	78	29.39	30.10	−.02	25.4	−4.2	52	4	33	−8	27	18	36	23	19	77	1.65	−0.2	5	5,769	nw.	33	sw.	23	7	11	13	6.1	10.8	T.
Cairo	358	87	93	29.71	30.11	−.04	35.8	−2.0	64	11	44	2	27	28	25	32	27	78	0.57	−2.8	5	7,109	sw.	44	sw.	4	10	7	14	5.7	1.1	0.0
Peoria	609	11	45	29.39	30.09	−.02	24.8	−3.3	49	4	32	−7	27	18	27	22	20	86	1.12	−1.2	7	5,412	nw.	25	s.	23	9	6	16	6.3	3.0	0.0
Springfield, Ill.	636	10	91	29.36	30.07	−.05	28.0	−3.7	57	12	35	−4	27	21	28	25	23	85	1.32	−1.1	6	6,876	w.	26	s.	23	10	9	12	5.7	2.2	T.
Hannibal	534	74	109	29.50	30.10	−.02	28.6	−2.9	57	12	36	−5	27	21	29	.....	.....	.....	1.54	−0.1	7	6,526	nw.	33	sw.	23	11	7	13	5.5	5.5	T.
St. Louis	568	265	303	29.46	30.09	−.04	32.8	−1.9	65	12	40	−1	27	25	27	29	24	72	1.46	−0.8	5	9,576	nw.	46	sw.	23	8	13	10	5.5	0.2	0.0
Missouri Valley							27.3	−0.3										78	0.86	−0.2										5.4		
Columbia, Mo	784	11	84	29.23	30.09	−.03	31.0	−2.2	63	3	39	−3	27	23	30	.....	.....	.....	1.88	−0.1	9	6,705	sw.	32	nw.	4	10	12	9	5.1	5.3	0.0
Kansas City	963	161	181	29.03	30.10	−.02	31.8	−0.7	64	3	40	−2	27	24	29	28	24	75	1.27	−0.1	8	9,379	nw.	44	nw.	4	11	8	12	5.4	5.0	0.0
St. Joseph	967	11	49	29.02	30.09	.....	29.5	.....	66	9	38	−4	27	21	34	26	22	78	0.92	.....	7	7,553	nw.	42	nw.	4	12	7	12	5.0	1.9	T.
Springfield, Mo	1,324	98	104	28.66	30.11	−.02	34.0	−2.2	62	12	42	−1	28	26	28	29	25	77	0.91	−1.8	8	8,312	nw.	36	nw.	4	13	9	9	4.6	1.8	.0
Iola	984	11	50	29.02	30.11	−.01	32.8	+0.3	70	3	43	0	27	23	33	.....	.....	.....	0.63	−0.3	3	5,670	n.	27	n.	4	17	3	11	4.9	2.2	0.0
Topeka	987	92	107	.....	.....	.....	31.8	−0.2	66	9	41	0	27	22	36	.....	.....	.....	0.19	−0.7	4	7,946	nw.	42	n.	4	13	7	11	5.2	0.5	0.0
Drexel	1,299	10	54	28.64	30.09	.....	23.7	.....	57	2	32	−11	27	15	29	.....	.....	.....	1.45	.....	6	8,446	nw.	33	nw.	4	12	8	11	5.2	12.1	5.0
Lincoln	1,189	11	84	28.80	30.12	.00	27.4	−0.2	62	2	36	−6	27	18	32	25	21	80	0.66	0.0	6	8,622	nw.	44	nw.	4	8	11	12	5.7	4.7	T.
Omaha	1,105	115	122	28.88	30.11	.00	26.0	−0.4	58	2	34	−9	27	18	30	23	18	73	1.42	+0.5	5	7,104	nw.	42	nw.	4	12	11	8	4.9	12.6	1.7
Valentine	2,598	47	54	27.32	30.14	+.04	26.0	+1.4	67	1	37	−15	28	15	39	22	18	79	1.01	+0.4	11	6,730	w.	31	nw.	3	12	8	11	5.2	15.8	0.2
Sioux City	1,135	94	164	28.86	30.14	+.02	22.0	−1.1	54	11	30	−12	27	14	36	20	16	79	0.95	+0.2	6	9,894	nw.	48	nw.	3	12	7	12	5.3	10.9	3.0
Huron	1,306	59	74	28.70	30.17	+.07	19.4	+0.7	52	11	28	−14	27	11	30	18	14	79	0.28	−0.3	4	7,065	nw.	37	nw.	4	8	11	12	6.1	3.7	2.7
Pierre	1,572	70	75	28.44	30.19	+.09	22.4	+0.6	63	2	32	−21	29	13	40	20	17	83	0.65	+0.2	8	5,557	nw.	36	nw.	2	7	9	15	6.5	6.7	2.0
Yankton	1,233	49	57	28.74	30.11	.00	23.2	+0.4	57	10	32	−11	29	15	39	.....	.....	.....	0.48	−0.2	2	6,669	nw.	32	nw.	4	7	11	13	6.4	3.0	1.5

TABLE 1.—*Climatological data for Weather Bureau stations, December, 1925*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall.	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Northern Slope							**28.3**	**+4.5**										**77**	**0.38**	**0.0**										**6.2**		
Billings	3,140	5					31.9		64	1	42	−4	27	21	35				1.32		9											
Havre	2,505	11	44	27.42	30.14	+.09	26.8	+6.4	61	1	37	−18	27	16	37	24	20	81	0.54	−0.1	5	5,058	sw.	30	sw.	1	10	13	8	5.0	5.4	5.4
Helena	4,110	87	112	28.25	30.17	+.04	34.2	+10.0	53	1	40	14	20	28	27	30	27	76	1.13	+0.3	9	5,951	sw.	38	sw.	5	7	7	17	6.6	14.4	0.0
Kalispell	2,973	48	56	27.05	30.18	+.11	33.4	+8.5	54	1	37	23	31	30	20	32	30	87	0.98	−0.9	12	2,430	nw.	27	sw.	1	1	5	25	8.9	2.6	T.
Miles City	2,371	48	55	27.57	30.22	+.12	25.6	+4.6	61	1	35	−30	27	16	35	22	19	78	0.71	+0.1	10	3,502	se.	27	w.	2	10	6	15	5.8	6.8	6.6
Rapid City	3,259	50	58	26.64	30.19	+.10	29.0	+2.1	67	2	40	−18	27	18	42	24	18	68	0.43	0.0	7	5,364	w.	36	nw.	2	11	5	15	5.9	3.9	1.1
Cheyenne	6,088	84	101	23.98	30.14	+.05	27.8	−0.7	52	9	37	0	27	19	37	24	19	70	1.74	+1.4	12	10,808	w.	51	w.	12	7	9	15	6.3	18.4	2.2
Lander	5,372	60	68	24.70	30.25	+.10	24.4	+4.0	49	10	35	−5	30	14	34	20	14	70	0.87	+0.2	5	2,292	sw.	36	w.	12	12	11	8	5.0	9.9	1.0
Sheridan	3,790	10	47	26.15	30.18	.....	29.4	.....	63	1	40	−4	27	19	41	25	22	79	1.70	.....	12	3,142	nw.	26	nw.	3	9	8	14	6.2	12.1	1.6
Yellowstone Park	6,241	11	48	23.94	30.26	+.10	25.7	+4.1	41	1	33	5	30	19	26	23	20	80	0.89	−0.9	17	4,417	s.	26	s.	12	4	9	18	7.3	7.9	3.8
North Platte	2,821	11	51	27.13	30.18	+.08	28.0	+1.3	61	9	39	−3	28	17	34	23	20	81	0.64	+0.2	6	5,942	n.	33	n.	3	15	2	14	5.0	7.3	0.3
Middle Slope							**34.0**	**+0.4**										**70**	**0.44**	**−0.3**										**4.4**		
Denver	5,292	106	113	24.75	30.16	+.08	32.0	−0.3	62	11	43	1	28	21	43	26	21	69	0.93	+0.3	12	5,700	s.	34	nw.	13	12	8	11	5.1	13.3	T.
Pueblo	4,685	80	86	25.31	30.12	+.04	33.4	+1.9	69	2	47	4	29	19	45	27	20	62	0.41	0.0	5	4,107	nw.	29	w.	26	15	7	9	4.5	3.3	0.0
Concordia	1,392	50	58	28.58	30.10	−.01	31.7	+1.0	62	9	42	−2	27	22	39	26	21	72	0.38	−0.1	7	6,852	nw.	36	nw.	4	12	7	12	5.1	2.8	0.0
Dodge City	2,509	11	51	27.46	30.16	+.06	34.0	+1.4	66	12	47	1	28	21	47	26	21	72	0.05	−0.5	3	7,661	nw.	41	nw.	3	21	3	7	3.2	0.5	0.0
Wichita	1,358	139	158	28.61	30.09	−.02	34.2	−0.4	64	9	44	1	28	25	31	29	24	72	0.59	−0.2	4	10,331	s.	46	n.	4	14	10	7	4.3	1.9	0.0
Broken Arrow	765	11	56	29.28	30.13	.....	36.7	.....	70	3	46	2	28	27	34	.....	.....	.....	0.41	.....	5	9,942	n.	46	nw.	4	12	10	9	4.7	0.2	0.0
Oklahoma City	1,214	10	47	28.81	30.14	+.03	38.4	−0.9	69	2	49	6	28	28	33	33	28	71	0.31	−1.4	3	8,803	s.	44	n.	4	15	11	5	4.1	0.1	0.0
Southern Slope							**41.3**	**−2.8**										**56**	**0.29**	**−0.6**										**4.4**		
Abilene	1,738	10	52	28.30	30.16	+.05	43.5	−2.5	74	3	55	15	28	32	40	34	24	53	T.	−1.1	0	7,193	s.	40	sw.	3	14	9	8	4.6	0.0	0.0
Amarillo	3,676	10	49	26.31	30.13	+.04	37.6	+0.6	70	26	50	10	28	26	50	30	23	63	0.37	−0.5	3	7,721	w.	38	sw.	2	17	7	7	3.3	3.3	0.0
Del Rio	944	64	71	29.16	30.17	+.07	47.2	−5.2	77	3	57	19	28	38	35	.....	.....	.....	0.71	−0.2	7	5,772	nw.	46	nw.	3	8	10	13	6.1	0.8	0.0
Roswell	3,566	75	85	26.44	30.14	+.07	37.0	−4.2	69	2	51	13	16	23	43	29	18	51	0.07	−0.5	2	5,205	n.	42	w.	19	18	7	6	3.5	0.6	T.
Southern Plateau							**42.9**	**+1.1**										**54**	**0.46**	**−0.1**										**3.3**		
El Paso	3,778	152	175	26.27	30.14	+.11	40.8	−4.1	68	1	52	17	28	30	32	32	19	43	0.27	−0.2	5	7,100	nw.	42	nw.	19	14	10	7	4.2	0.8	0.0
Santa Fe	7,013	38	53	23.23	30.14	+.08	29.0	−1.7	53	26	39	7	28	19	29	23	17	66	0.68	−0.1	3	4,346	ne.	28	ne.	3	18	6	7	3.5	7.2	3.5
Flagstaff	6,907	10	59	23.34	30.05	−.01	32.8	+4.4	53	26	44	11	21	22	39	26	.....	66	0.59	.....	3	6,305	e.	44	e.	5	20	6	5	.....	1.4	0.0
Phoenix	1,108	10	82	28.87	30.04	.00	53.5	+1.5	78	26	67	30	21	40	40	43	31	48	0.40	−0.2	2	3,861	e.	20	e.	8	18	5	8	3.5	0.0	0.0
Yuma	141	9	54	29.89	30.04	−.01	56.4	+1.2	75	25	68	37	13	45	33	46	33	45	0.80	+0.4	4	4,527	n.	32	n.	14	20	4	7	3.1	0.0	0.0
Independence	3,957	5	25	26.03	30.12	.00	44.8	+5.5	71	6	60	29	28	30	39	33	.....	.....	0.13	−0.6	1	.....	nw.	.....	.....	.....	17	7	7	2.1	0.0	0.0
Middle Plateau							**33.3**	**+3.0**										**69**	**0.56**	**−0.3**										**4.6**		
Reno	4,532	74	81	25.59	30.25	+.10	35.5	+1.8	59	6	48	16	14	23	34	31	26	72	0.11	−1.1	2	2,776	w.	36	se.	17	18	6	7	3.7	1.4	0.0
Tonopah	6,090	12	20	.....	.....	.....	36.4	.....	52	25	43	16	14	30	18	30	20	51	0.08	.....	1	.....	nw.	.....	.....	.....	.....	.....	.....	.....	.....	.....
Winnemucca	4,344	18	56	25.78	30.28	+.10	32.4	+2.4	55	8	44	10	31	21	31	28	25	79	0.96	0.0	7	4,283	ne.	35	nw.	2	15	12	4	4.0	5.2	0.0
Modena	5,479	10	43	24.70	30.19	+.07	31.0	+2.9	54	28	43	9	15	19	38	26	21	71	0.26	−0.3	4	4,965	e.	35	sw.	2	17	5	9	4.2	0.6	0.3
Salt Lake City	4,360	163	203	25.76	30.22	+.07	35.4	+3.5	52	1	41	24	31	30	20	32	28	75	0.83	−0.5	5	3,608	nw.	38	sw.	18	8	4	19	6.7	2.1	0.0
Grand Junction	4,602	60	68	25.49	30.16	+.06	32.0	+4.5	52	7	42	14	15	22	29	27	21	67	0.64	+0.2	3	3,174	se.	18	nw.	2	16	8	7	4.6	4.5	0.0
Northern Plateau							**35.6**	**+4.1**										**85**	**1.29**	**−0.4**										**3.3**		
Baker	3,471	48	53	.....	30.30	+.14	29.3	+2.0	51	5	36	5	31	23	27	.....	.....	86	1.00	−0.5	9	3,511	se.	18	se.	17	4	5	22	.....	10.4	0.3
Boise	2,739	78	86	27.38	30.32	+.12	35.0	+2.9	57	1	40	20	31	30	19	33	30	83	1.03	−0.7	11	2,473	nw.	22	ne.	17	2	7	22	8.1	2.6	0.0
Lewiston	757	40	48	29.40	30.23	+.10	40.1	+4.4	62	23	45	28	19	35	23	.....	.....	.....	1.29	−0.2	11	2,429	e.	24	s.	11	1	8	22	7.9	0.0	0.0
Pocatello	4,477	60	68	25.60	30.24	+.05	32.3	+4.6	54	1	38	12	30	26	26	30	27	82	0.57	−0.3	6	5,745	se.	38	s.	23	4	7	20	7.6	0.8	0.0
Spokane	1,929	101	110	28.11	30.22	+.14	36.4	+5.9	57	1	40	27	19	33	23	35	34	90	2.02	−0.6	14	3,474	s.	22	s.	11	0	4	27	9.0	3.4	0.0
Walla Walla	991	57	65	29.13	30.22	+.10	40.4	+4.9	64	1	46	29	14	35	29	38	34	82	1.84	−0.3	11	2,716	s.	21	se.	17	2	3	26	8.7	T.	0.0
North Pacific Coast Region							**45.8**	**+3.4**										**87**	**7.05**	**−0.4**										**6.7**		
North Head	211	11	56	29.85	30.08	+.05	48.6	+4.5	61	7	52	39	31	45	15	46	42	81	11.18	+3.7	19	13,772	s.	60	nw.	12	4	4	23	8.1	0.0	0.0
Port Angeles	29	8	53	.....	30.08	.....	43.3	.....	55	4	47	33	29	39	16	.....	.....	.....	2.76	−2.4	19	3,264	s.	32	sw.	18	1	3	27	.....	0.0	0.0
Seattle	125	215	250	29.96	30.10	+.09	45.6	+3.9	57	1	50	30	31	42	15	44	42	88	4.30	−1.0	16	5,389	s.	32	s.	1	1	11	19	7.9	0.0	0.0
Tacoma	194	172	210	29.90	30.11	+.10	44.6	+4.0	58	5	49	28	31	40	17	.....	.....	.....	5.08	−1.8	17	4,881	s.	34	sw.	1	0	9	22	8.5	0.0	0.0
Tatoosh Island	86	9	53	29.93	30.03	+.07	47.5	+3.6	55	7	50	39	13	45	10	46	45	93	17.26	+2.7	20	17,256	e.	75	s.	11	4	8	19	7.8	0.0	0.0
Yakima	1,071	5	.....	.....	.....	.....	35.8	.....	56	6	42	20	16	29	32	.....	.....	.....	1.02	.....	5	.....	ne.	.....	.....	.....	3	8	20	7.7	3.6	0.0
Medford	1,425	4	.....	.....	.....	.....	37.4	.....	56	17	44	24	15	31	28	35	33	86	1.73	.....	11	.....	se.	.....	.....	.....	2	3	26	.....	0.0	0.0
Portland, Oreg	153	68	106	29.97	30.14	+.07	45.8	+4.6	62	23	51	32	9	41	17	44	41	84	5.14	−1.8	12	4,836	se.	24	e.	31	7	5	19	6.9	0.0	0.0
Roseburg	510	9	57	29.61	30.17	+.06	42.7	+0.9	62	23	48	31	15	38	19	41	38	91	3.66	−2.3	12	1,563	s.	18	sw.	18	1	12	18	7.8	0.0	0.0
Middle Pacific Coast Region							**50.0**	**+1.3**										**80**	**2.19**	**−2.2**										**4.6**		
Eureka	62	73	89	30.08	30.15	+.03	51.1	+1.9	65	26	57	35	13	43	21	48	46	86	4.84	−2.4	10	3,157	se.	32	s.	17	11	6	14	5.7	0.0	0.0
Point Reyes	490	7	18	29.53	30.05	.....	54.1	+3.5	69	6	59	44	30	49	22	.....	.....	.....	0.80	.....	6	9,310	n.	72	nw.	2	14	11	6	3.9	0.0	0.0
Red Bluff	332	50	56	29.78	30.15	+.01	48.1	+2.0	79	5	58	29	30	39	37	44	39	75	2.26	−2.2	4	3,036	nw.	25	nw.	13	13	9	9	4.8	0.0	0.0
Sacramento	69	106	117	30.06	30.13	−.01	46.0	−0.2	65	7	52	34	14	40	26	44	42	85	1.50	−2.0	4	3,485	se.	25	nw.	2	12	6	13	5.4	0.0	0.0
San Francisco	155	208	243	29.94	30.11	−.01	52.7	+1.4	70	5	58	40	30	47	18	48	44	76	1.01	−3.2	5	4,996	nw.	25	nw.	2	16	11	4	3.6	0.0	0.0
San Jose	141	12	110	29.97	30.12	.....	49.0	−0.9	75	6	60	32	14	38	35	.....	.....	.....	1.33	−1.3	5	3,055	nw.	23	se.	17	13	11	7	4.4	0.0	0.0
South Pacific Coast Region							**56.8**	**+2.9**										**63**	**2.06**	**0.0**										**3.7**		
Fresno	327	89	98	29.78	30.14	+.01	46.2	0.0	72	8	54	30	16	39	28	43	40	82	1.31	−0.2	3	2,569	nw.	25	nw.	2	11	7	13	5.6	0.0	0.0
Los Angeles	338	159	191	29.66	30.03	−.04	63.2	+6.6	82	25	72	47	14	54	24	51	41	51	2.45	−0.4	3	3,777	ne.	20	nw.	19	18	9	4	2.9	0.0	0.0
San Diego	87	62	70	29.92	30.01	−.06	60.3	+4.3	83	25	69	45	13	51	30	52	46	65	1.50	−0.3	6	3,132	nw.	18	nw.	22	17	4	10	3.8	0.0	0.0
San Luis Obispo	201	32	40	29.86	30.08	−.03	57.6	+4.6	83	25	72	32	15	44	43	46	36	54	3.00	+0.7	3	2,689	n.	20	ne.	22	22	7	2	2.5	0.0	0.0
West Indies																																
San Juan, P. R	82	9	54	29.90	29.99	.....	76.2	−0.1	88	2	82	67	13	70	16	.....	.....	.....	0.98	−5.2	12	6,831	e.	33	ne.	29	16	13	2	3.8	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97	29.70	29.82	−.02	81.4	+1.4	91	20	89	70	27	74	19	75	74	89	1.88	−2.3	11	5,970	nw.	25	n.	31	5	20	6	5.6	0.0	0.0
Colon	38	7	97	29.80	29.84	−.02	82.0	+2.0	88	15	86	73	27	78	13	77	75	86	6.04	−4.0	15	9,758	n.	28	n.	23	7	17	7	5.6	0.0	0.0
Alaska																																
Juneau	80	11	54	.....	.....	.....	38.2	.....	58	8	42	28	12	34	18	36	33	84	10.14	.....	25	5,885	se.	37	e.	21	0	1	30	9.8	13.9	0.0
Hawaiian Islands																																
Honolulu	38	86	100	.....	.....	.....	73.7	.....	82	16	79	63	26	69	16	67	65	76	2.63	−1.3	12	5,724	e.	37	sw.	21	7	18	6	5.2	0.0	0.0

TABLE 2.—*Data furnished by the Canadian Meteorological Service, December, 1925*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+ mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*Inches*	*Inches*	*Inches*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*Inches*	*Inches*	*Inches*
St. Johns, N. F.	125												
Sydney, C. B. I.	48	29.67	29.72	0.17	25.4	−2.8	32.0	18.0	49	7	2.21	−2.42	8.5
Halifax, N. S.	88	29.64	29.75	−.21	26.5	−1.1	33.5	19.5	49	−2	2.78	−2.34	6.6
Yarmouth, N. S.	65	29.65	29.72	−.26	29.8	−0.9	35.7	24.0	50	10	3.10	−1.94	18.1
Charlottetown, P. E. I.	38	29.66	29.70	−.24	22.4	−1.9	28.6	16.2	46	−2	1.98	−1.68	17.5
Chatham, N. B.	28	29.61	29.64	−.30	16.5	−0.5	24.9	8.2	39	−12	1.52	−1.70	11.6
Father Point, Que.	20	29.69	29.71	−.24	16.4	+1.0	24.3	8.5	43	−10	2.66	−0.17	23.7
Quebec, Que.	296	29.48	29.81	−.20	16.8	+1.6	22.5	11.0	40	−10	2.72	−0.97	22.2
Montreal, Que.	187	29.62	29.84	−.19	20.2	+1.9	26.3	14.2	45	−13	4.03	+0.38	25.2
Stonecliffe, Ont.	489												
Ottawa, Ont.	236	29.60	29.88	−.14	19.1	+2.1	25.1	13.1	43	−16	3.22	+0.31	15.9
Kingston, Ont.	285	29.57	29.91	−.13	24.5	+0.8	30.0	18.9	52	−18	2.82	−0.42	6.5
Toronto, Ont.	379	29.49	29.92	−.13	26.5	−0.5	31.6	21.3	45	−14	1.30	−1.61	9.4
Cochrane, Ont.	930												
White River, Ont.	1,244	28.48	29.85	−.12	6.6	−3.1	16.7	−3.4	36	−34	1.38	−0.33	6.5
Port Stanley, Ont.	592												
Southampton, Ont.	656												
Parry Sound, Ont.	638	29.18			25.2	−1.5	30.8	19.6	50	−6	4.51	+0.53	36.6
Port Arthur, Ont.	644	29.16	29.89	−.12	20.7	−0.5	27.1	14.3	47	−25	2.83	−1.65	24.2
Winnipeg, Man.	760	29.24	29.98	−.01	12.2	−1.0	18.2	6.2	38	−15	0.78	−0.09	5.2
Minnedosa, Man.	1,690	28.21	30.13	+.11	12.0	+6.3	19.8	4.2	46	−18	0.15	−0.47	1.4
Le Pas, Man.	860				6.1		13.6	−1.4	38	−20	0.47		4.7
Qu'Appelle, Sask.	2,115	27.76	30.11	+.11	15.1	+7.7	21.9	8.3	47	−20	0.08	−0.44	0.6
Medicine Hat, Alb.	2,144	27.70	30.02	+.05	26.9	+8.7	36.2	17.6	60	−21	0.53	−0.02	5.3
Moose Jaw, Sask.	1,759				17.9		25.8	10.1	55	−26	0.30		2.9
Swift Current, Sask.	2,392	27.50	30.14	+.15	20.6	+4.6	28.9	12.3	52	−22	0.23	−0.55	2.3
Calgary, Alb.	3,428	26.39	30.05	+.11	31.5	+13.3	40.7	22.3	62	3	0.22	−0.37	2.2
Banff, Alb.	4,521	25.39	30.11	+.17	27.2	+8.1	33.7	20.7	47	−1	0.25	−0.96	1.0
Edmonton, Alb.	2,150	27.64	30.00	+.07	20.4	+7.3	26.8	14.0	51	−3	0.70	0.00	6.7
Prince Albert, Sask.	1,450	28.52	30.18	+.17	12.7	+9.9	20.0	5.5	44	−29	0.04	−0.70	0.4
Battleford, Sask.	1,592	28.31	30.13	+.14	15.8	+10.4	24.3	7.4	50	−22	0.10	−0.22	1.0
Kamloops, B. C.	1,262	28.82	30.15	+.21	35.7	+6.8	39.4	32.1	49	24	1.55	+0.77	9.2
Victoria, B. C.	230	29.81	30.07	+.10	44.8	+3.6	47.3	42.3	53	36	4.79	−3.19	0.0
Barkerville, B. C.	4,180	25.61	29.98	+.10	28.6	+7.7	33.1	24.2	41	7	6.67	+3.50	34.2
Triangle Island, B. C.	680												
Prince Rupert, B. C.	170				43.5		49.9	37.2	58	25	13.40		0.0
Hamilton, Ber.	151	29.88	30.05	−.07	64.9	+0.2	70.3	59.5	76	50	3.78	−0.71	0.0

LATE REPORTS, NOVEMBER, 1925

St. Johns, N. F.	125	29.76	29.90	−.04	35.4	+1.1	39.7	31.1	50	24	1.44	−4.13	13.0
Sydney, C. B. I.	48	29.96	30.01	+.06	35.5	−1.6	43.0	28.0	56	16	4.04	−1.40	T.
Halifax, N. S.	88	29.92	30.03	+.02	37.4	+0.1	45.0	29.3	55	12	3.48	−2.18	0.6
Yarmouth, N. S.	65	29.91	29.98	−.04	37.8	−2.1	44.1	31.5	56	10	4.27	−0.29	0.5
Charlottetown, P. E. I.	38	29.92	29.96	.00	35.4	−0.1	40.5	30.3	54	7	1.85	−2.12	0.3
Chatham, N. B.	28	29.85	29.88	−.09	31.5	+0.5	40.1	22.9	56	−1	3.79	+0.04	T.
Cochrane, Ont.	930				24.0		31.4	16.6	47	−17	0.80		3.0
Edmonton, Alb.	2,150	27.57	29.92	−.05	23.9	+1.0	32.4	15.5	48	−20	0.80	+0.22	8.0
Kamloops, B. C.	1,262	28.78	30.11	+.15	35.7	+2.3	42.1	29.3	58	18	0.15	−1.31	T.
Victoria, B. C.	230	29.80	30.06	+.07	44.7	+1.5	48.5	41.0	55	35	1.79	−5.18	0.0
Barkerville, B. C.	4,180	25.58	29.96	+.06	26.6	+3.0	32.3	20.9	43	4	3.45	+0.16	33.7

Chart I. Tracks of Centers of Anticyclones, December, 1925. (Inset) Departure of Monthly Mean Pressure from Normal

Chart I. Tracks of Centers of Anticyclones, December, 1925. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by Wilfred P. Day)

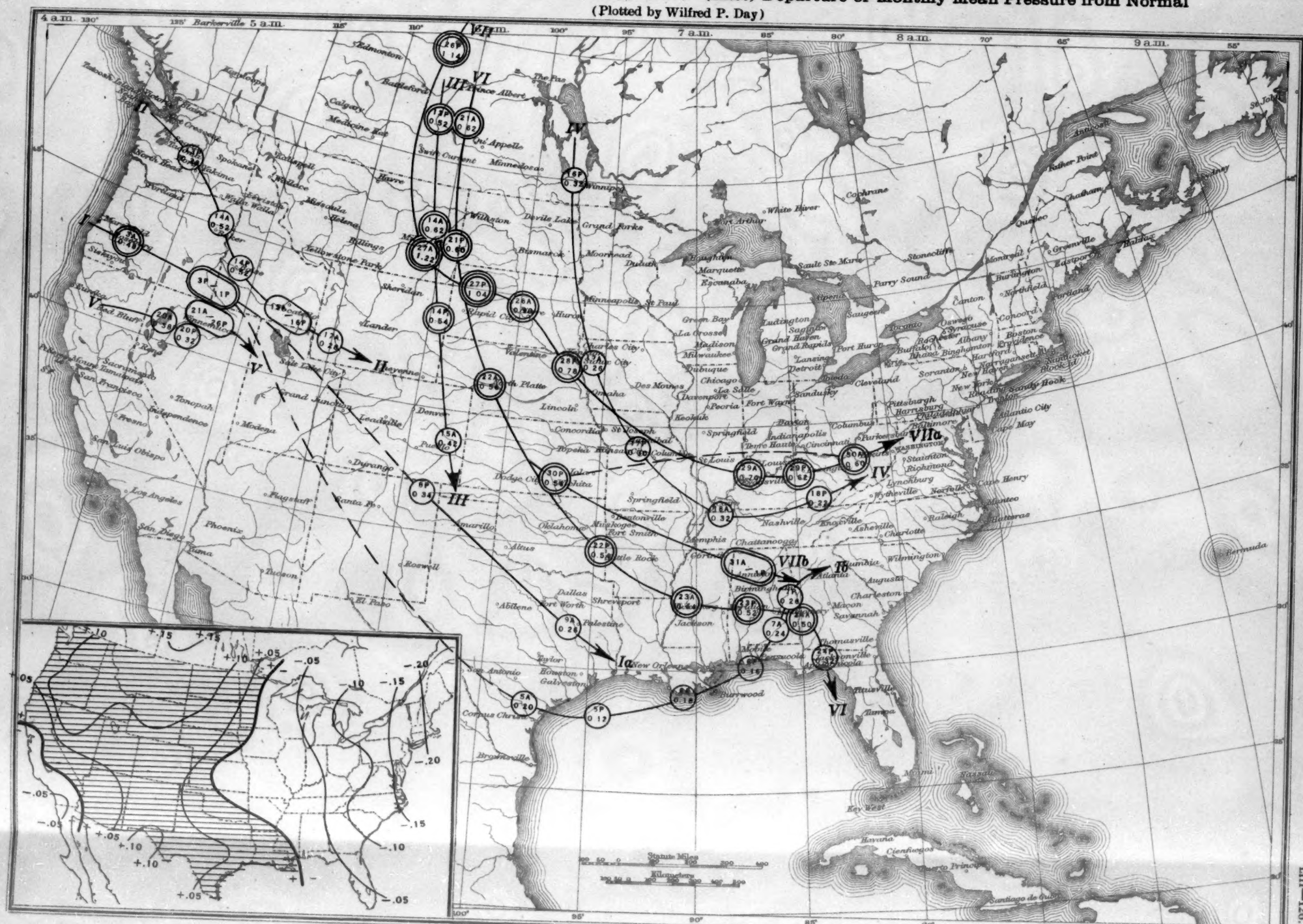

Chart II. Tracks of Centers of Cyclones, December, 1925. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by Wilfred P. Day)

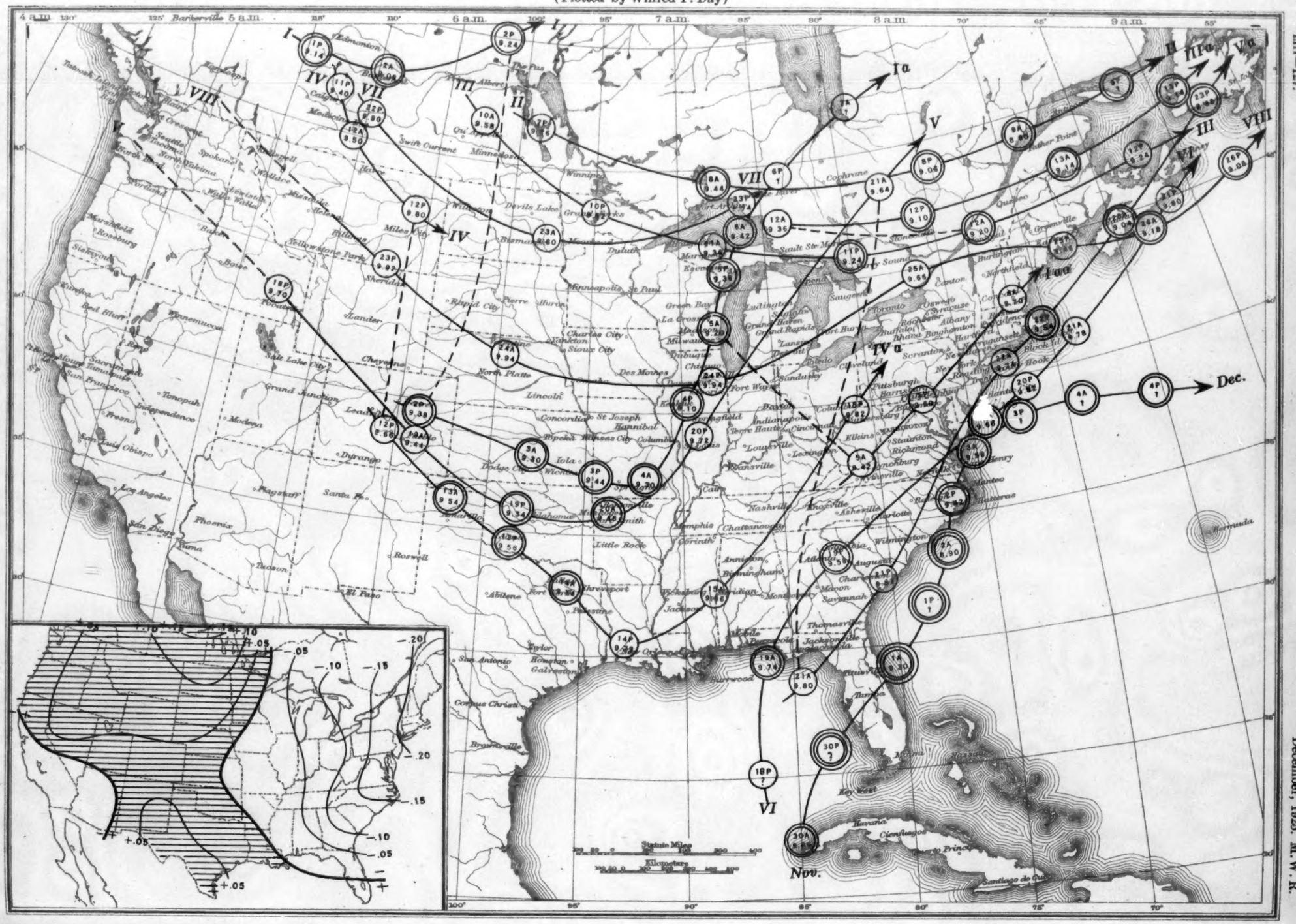

Chart III. Departure (°F.) of the Mean Temperature from the Normal, December, 1925

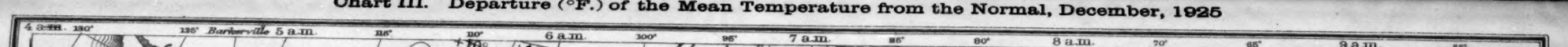

Chart III. Departure (°F.) of the Mean Temperature from the Normal, December, 1925

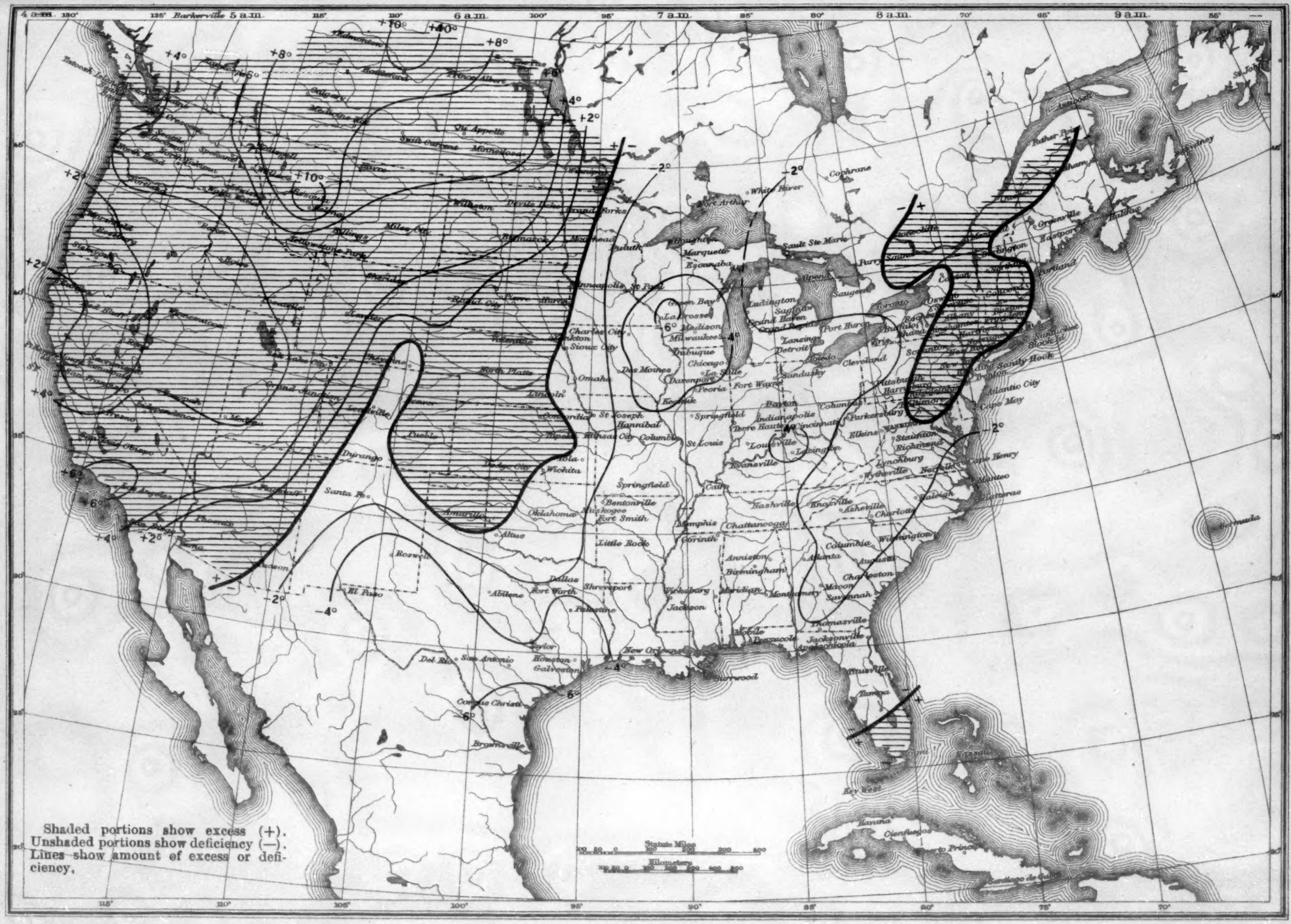
Shaded portions show excess (+).
Unshaded portions show deficiency (—).
Lines show amount of excess or deficiency.
Statute Miles
Kilometers

Chart IV. Total Precipitation, Inches, December, 1925. (Inset) Departure of Precipitation from Normal

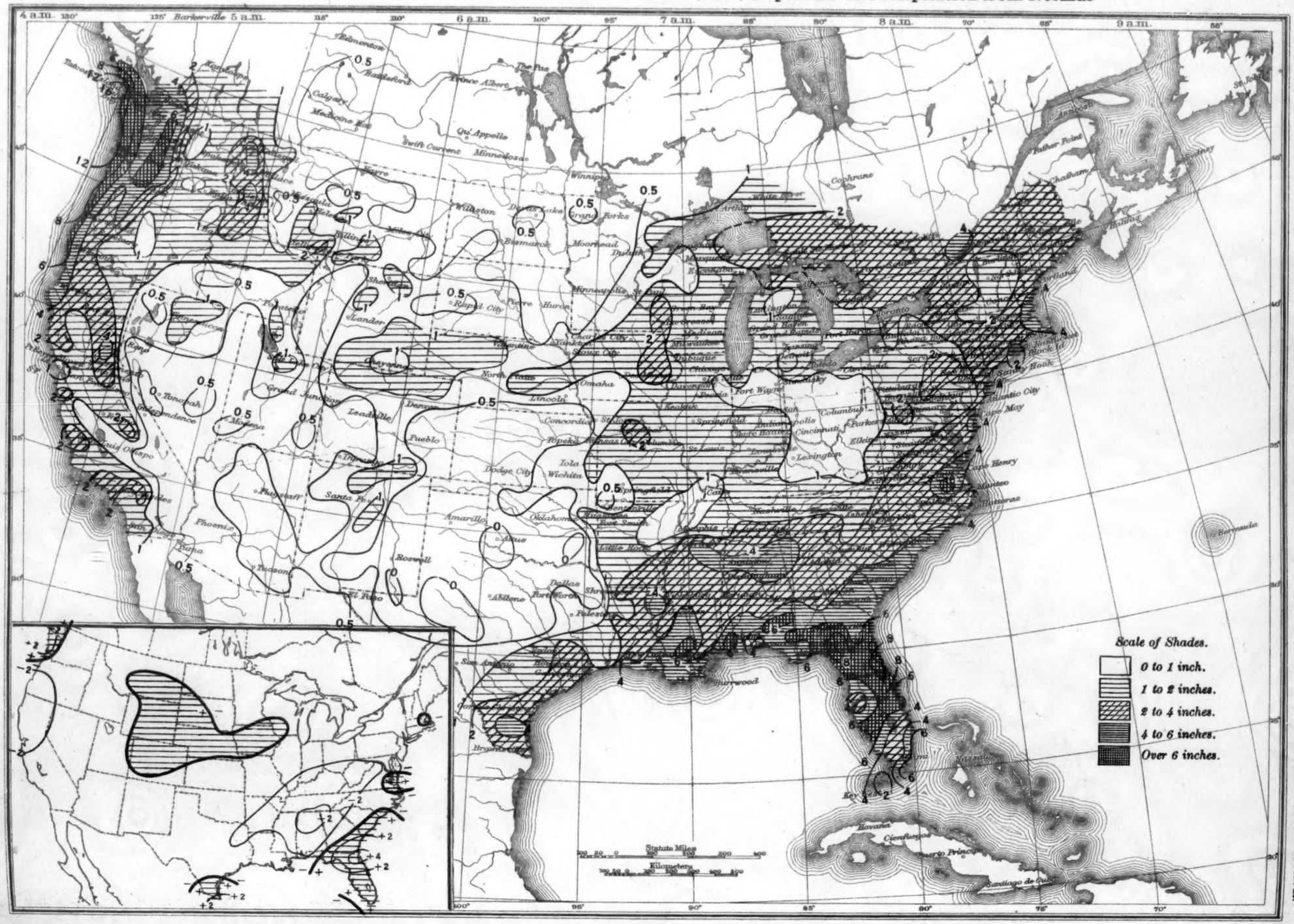

Chart V. Percentage of Clear Sky between Sunrise and Sunset, December, 1925

Chart V. Percentage of Clear Sky between Sunrise and Sunset, December, 1925

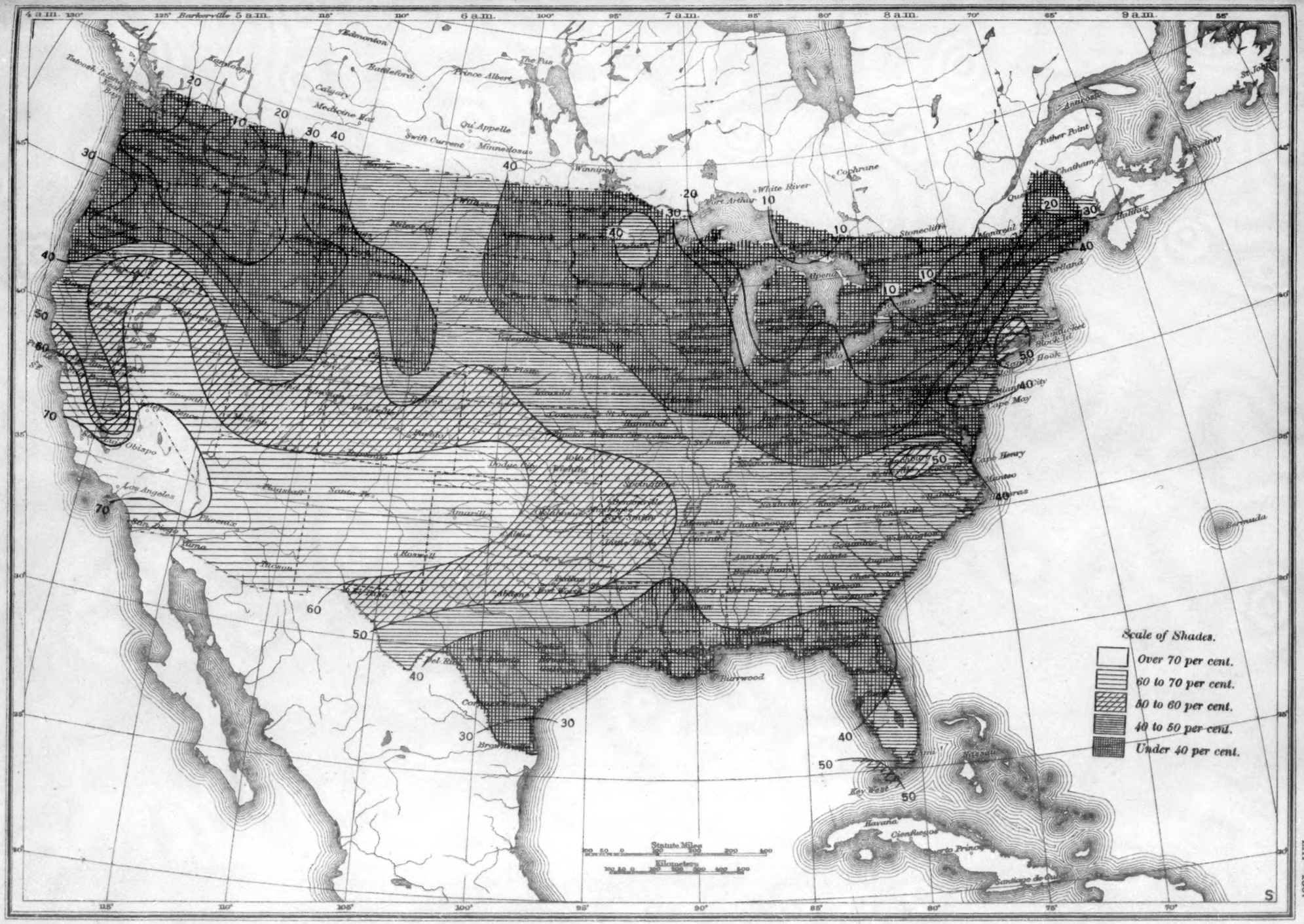

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, December, 1925

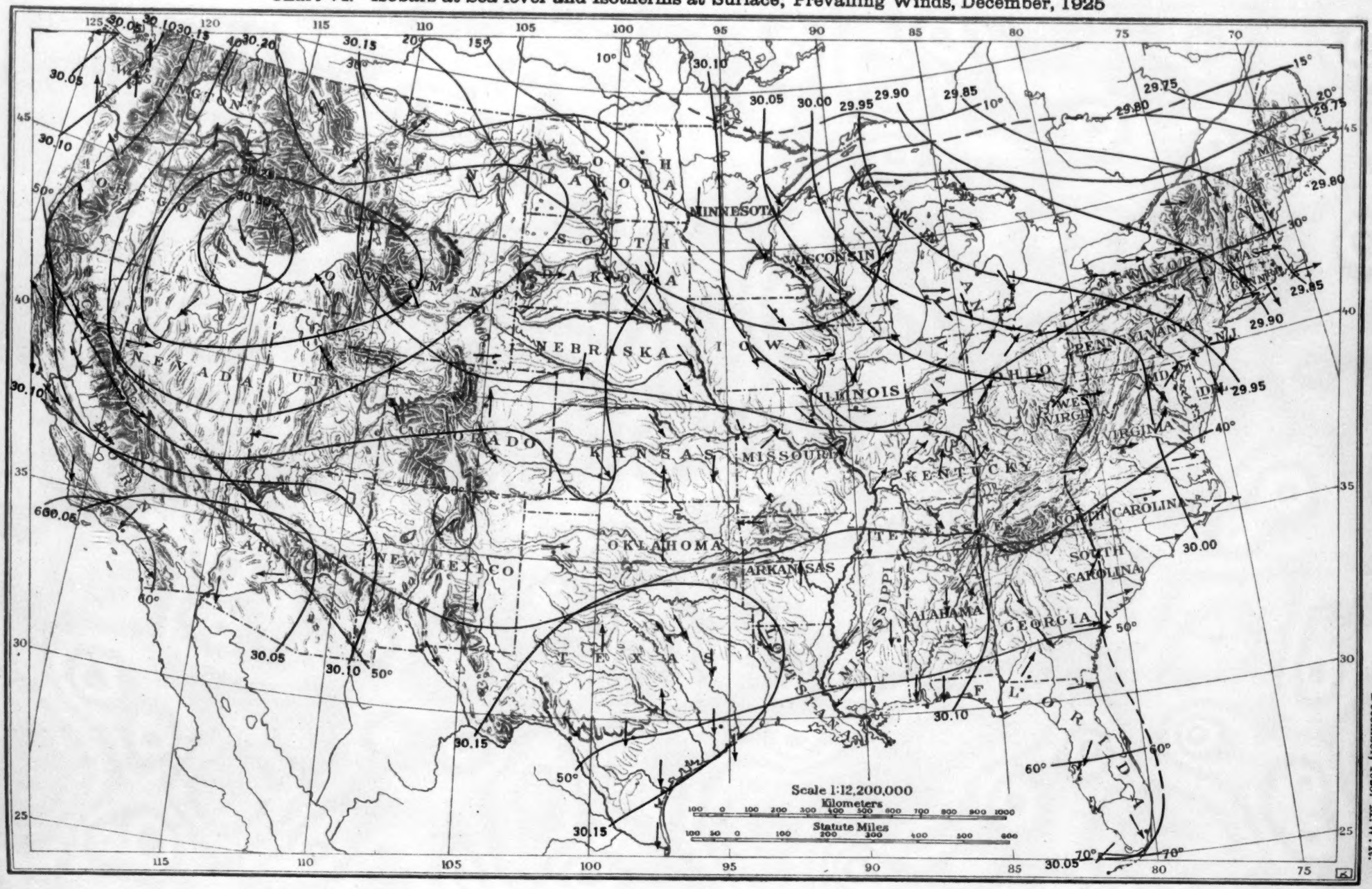

Chart VII. Total Snowfall, Inches, December, 1925. (Inset) Depth of Snow on Ground at end of Month

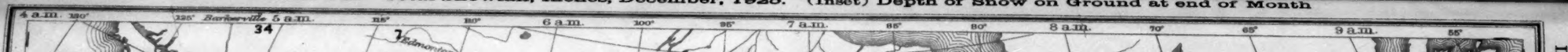

Chart VII. Total Snowfall, Inches, December, 1925. (Inset) Depth of Snow on Ground at end of Month

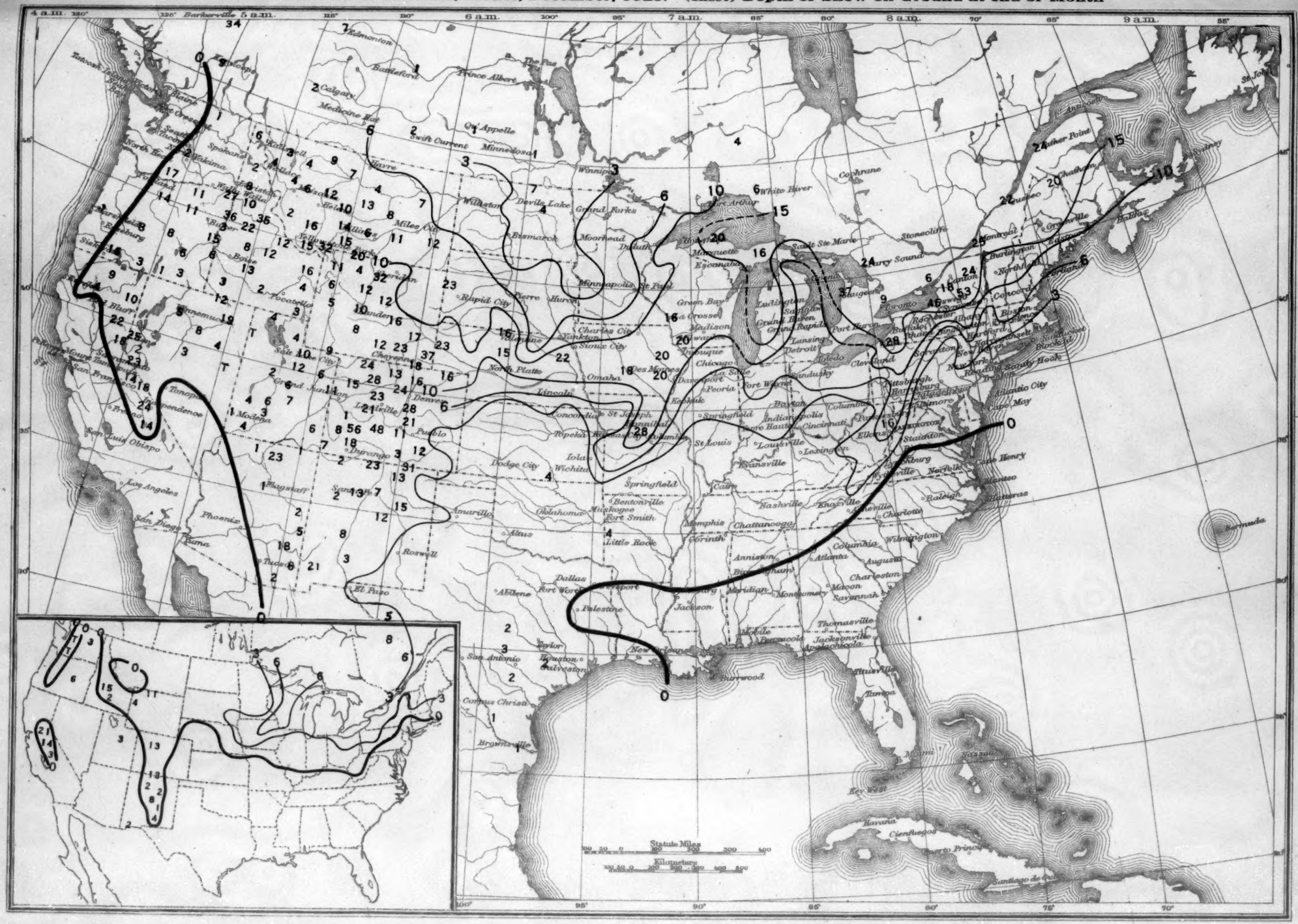

Chart VIII. Weather Map of North Atlantic Ocean, December 1, 1925
(Plotted by F. A. Young)

Chart VIII. Weather Map of North Atlantic Ocean, December 1, 1925

(Plotted by F. A. Young)

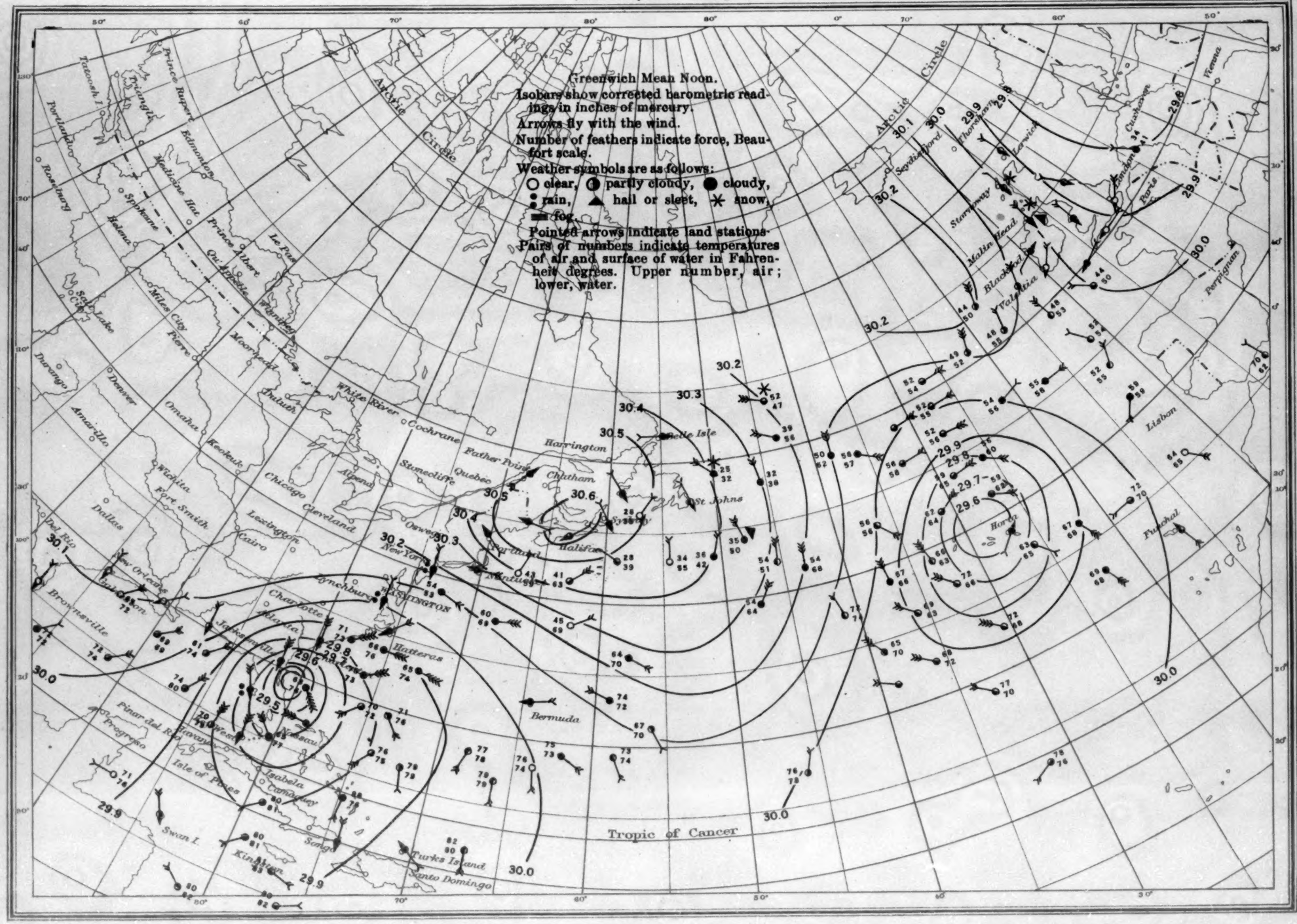

Chart IX. Weather Map of North Atlantic Ocean, December 2, 1925

(Plotted by F. A. Young)

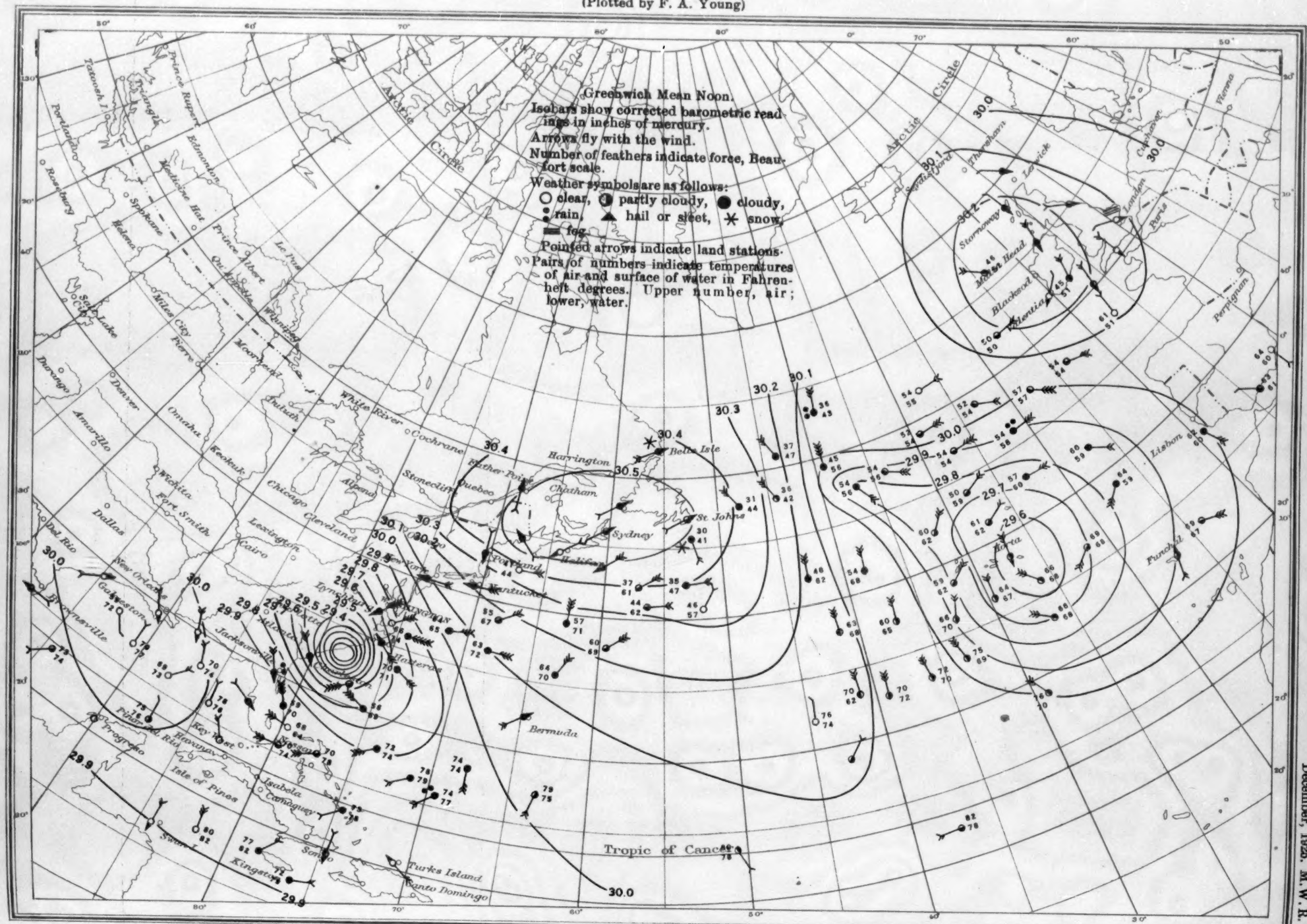

Chart X. Weather Map of North Atlantic Ocean, December 3, 1925

(Plotted by F. A. Young)

Chart X. Weather Map of North Atlantic Ocean, December 3, 1925

(Plotted by F. A. Young)

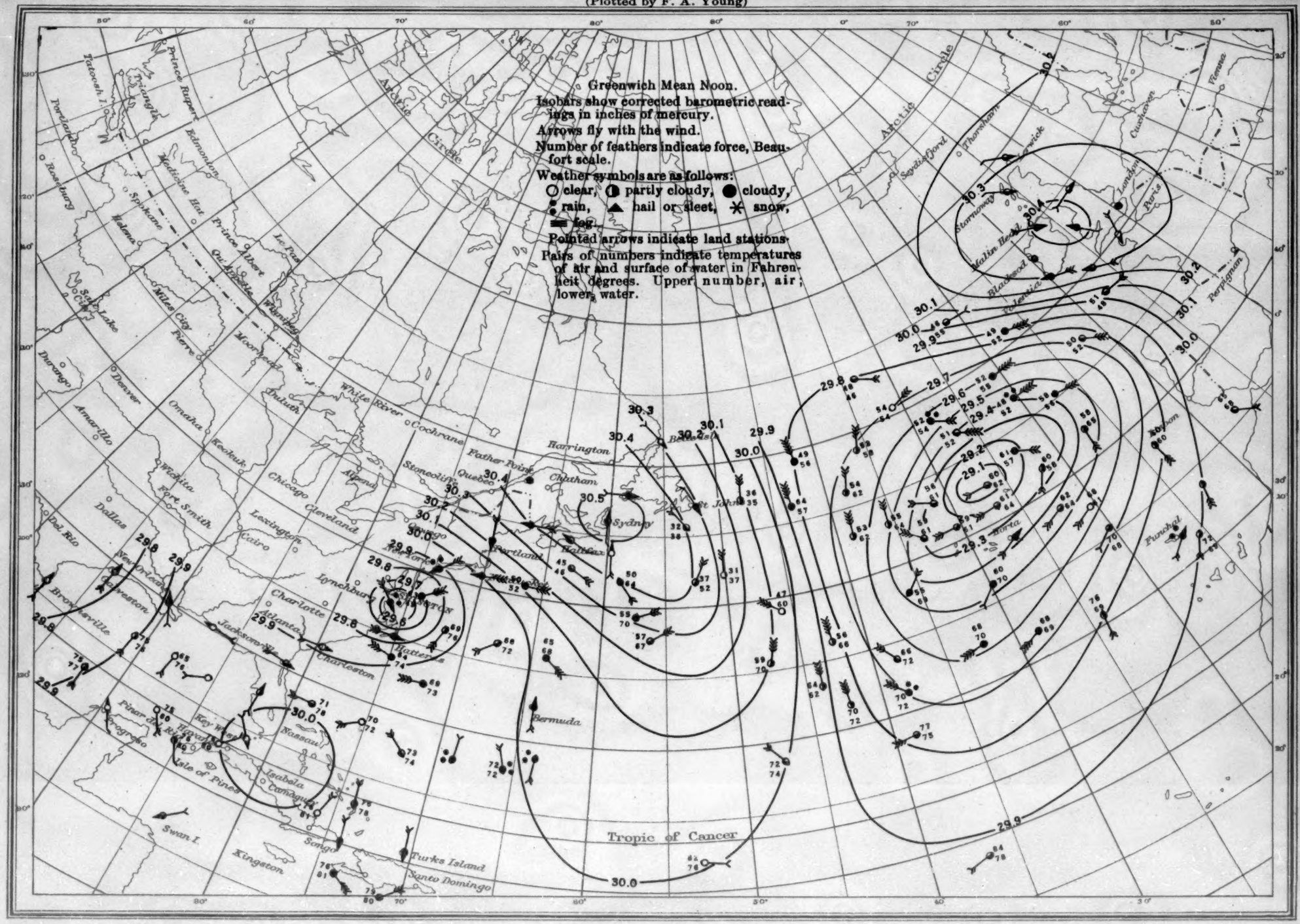

Chart XI. Weather Map of North Atlantic Ocean, December 4, 1925

(Plotted by F. A. Young)

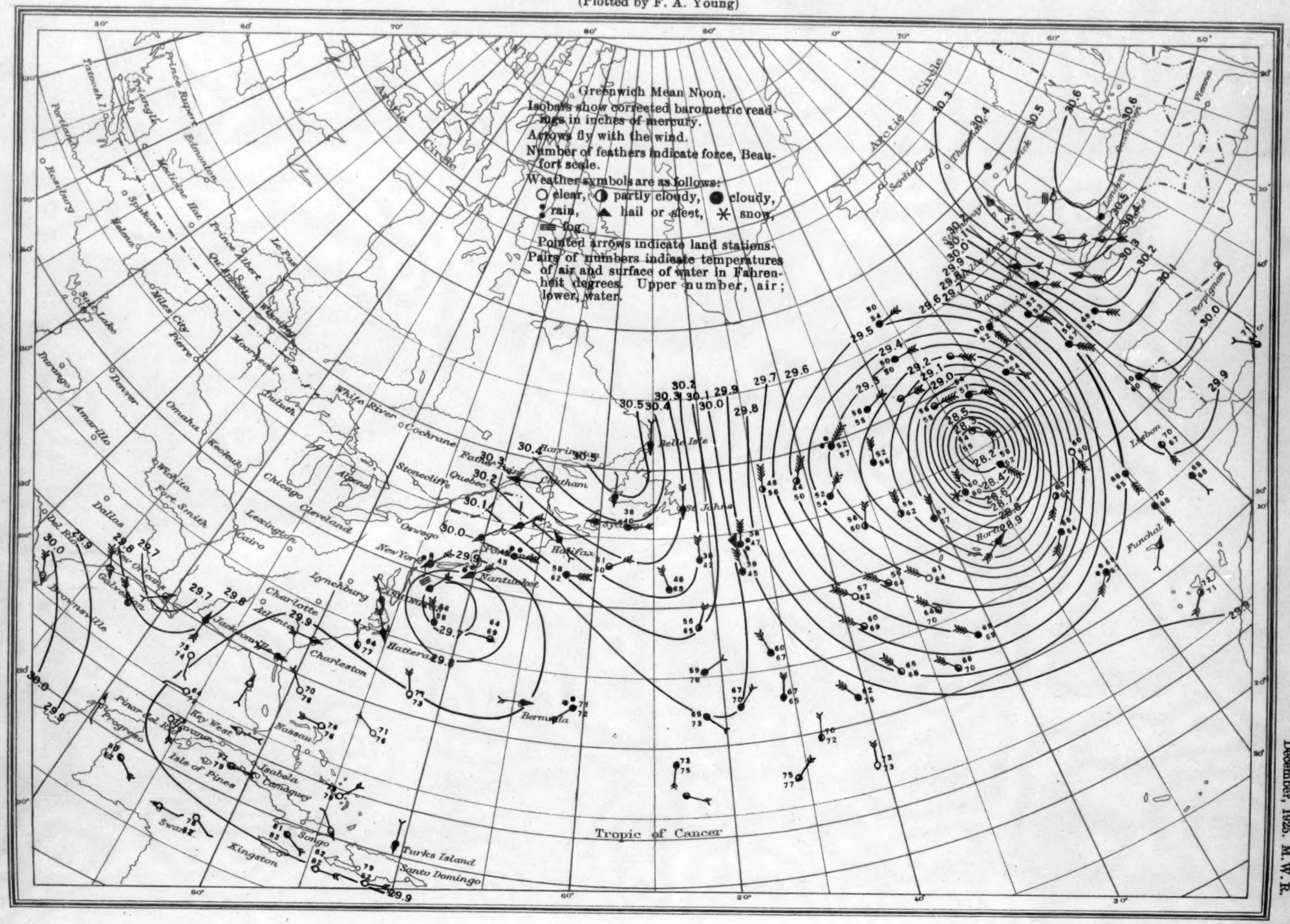

Chart XII. Weather Map of North Atlantic Ocean, December 5, 1925

Chart XII. Weather Map of North Atlantic Ocean, December 5, 1925

(Plotted by F. A. Young)

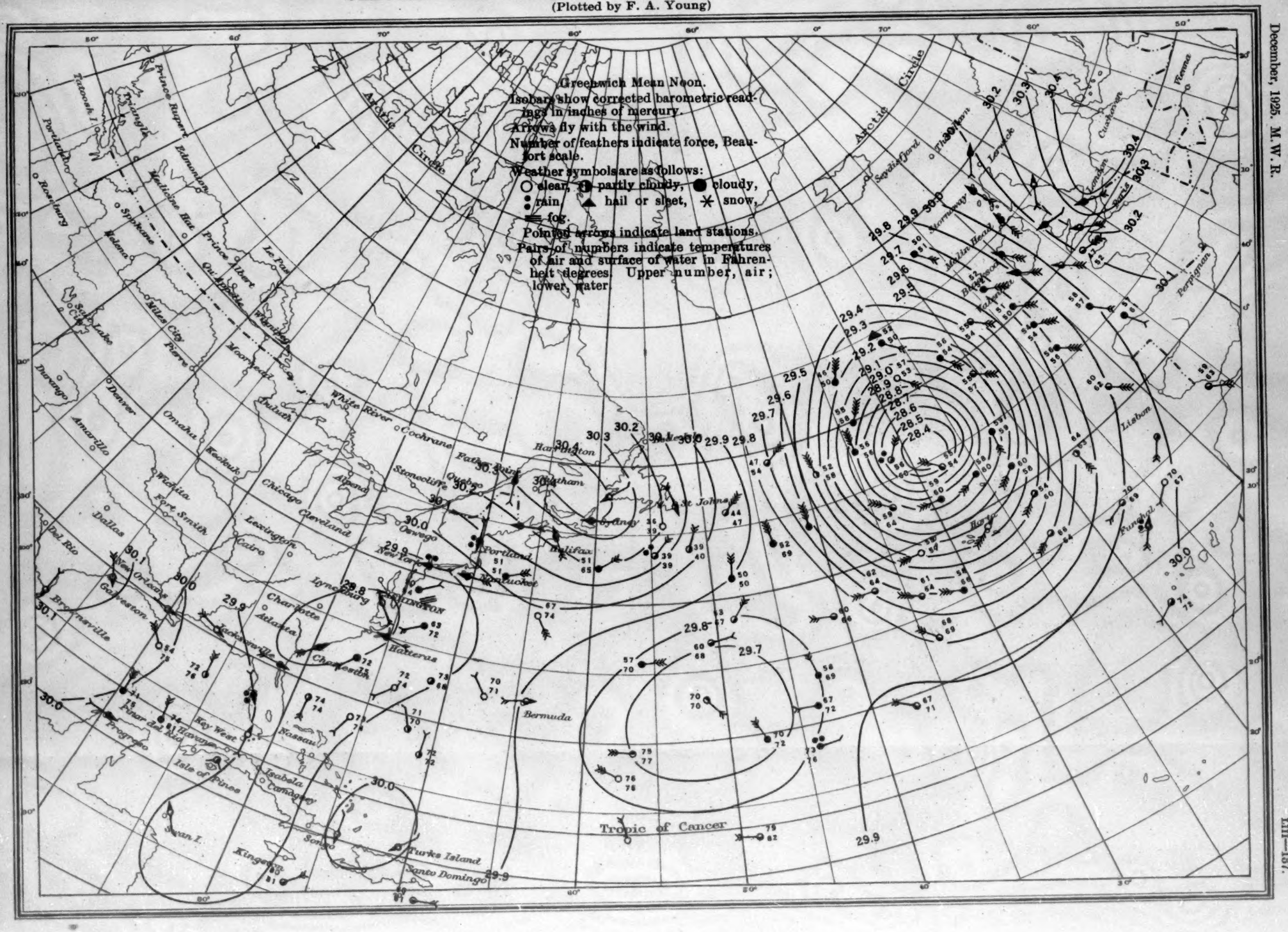

Chart XIII. Paths of Hurricanes and Other Tropical Storms, 1925

(Approximate position at each observation hour)

(Plotted by W. P. Day)

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